REPORT RESUMES

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TRENDS IN ENGINEERING TECHNICIAN ENROLLMENTS AND GRADUATES.
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TECHNICIAN ENROLLMENTS AND GRADUATES WERE SURVEYED (1965-66) IN FIVE CLASSIFICATIONS WITH VARYING EDUCATIONAL REQUIREMENTS--(1) ENGINEERING TECHNICIAN, (2) PHYSICIAL SCIENCE TECHNICIAN, (3) INDUSTRIAL TECHNICIAN, (4) PRE-ENGINEERING TRANSFER, AND (5) BACHELOR OF TECHNOLOGY. THE DATA WERE USED TO DETERMINE PRESENT TRENDS IN MANPOWER TRAINING AND USE AND TO PREDICT FUTURE SUPPLY AND DEMAND. WHILE THERE IS MAJOR GROWTH IN THE INDUSTRIAL TECHNICIAN PROGRAMS, THE DECREASE IN OVERALL ENROLLMENT FIGURES INDICATES THAT IN THE NEAR FUTURE THE DEMAND FOR QUALIFIED GRADUATES CANNOT BE MET. A JURY OF EXPERTS HAS COMPARED THE BACCALAUREATE ENGINEERING TECHNOLOGY PROGRAMS WITH BOTH 2-YEAR AND 4-YEAR ENGINEERING PROGRAMS AND HAS FOUND THE BACCALAUREATE ENGINEERING TECHNOLOGY PROGRAMS TO BE MORE FLEXIBLE. A COMMITTEE OF THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT HAS DEVELOPED GUIDELINES FOR THE EVALUATION AND ACCREDITATION OF THE 4-YEAR PROGRAMS IN ENGINEERING TECHNOLOGY. THE REPORT CONTAINS A LIST OF THE INSTITUTIONS WHICH RESPONDED TO THE SURVEY AND OF THE SCHOOLS ACCREDITED BY THE ECPD. (HH)

ED014298

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TRENDS IN
ENGINEERING TECHNICIAN
ENROLLMENTS AND GRADUATES

UNIVERSITY OF CALIF.
LOS ANGELES

OCT 6 1967

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A REPORT FROM THE

ENGINEERING MANPOWER COMMISSION
OF ENGINEERS JOINT COUNCIL

JC 690 871

The Engineering Manpower Commission of Engineers Joint Council is charged with the responsibility of developing programs to:

1. Aid in establishing the importance of engineering to the national interest.
2. Aid in maintaining an adequate supply of engineers.
3. Promote the most effective utilization of engineers in support of the national health, safety, and interest.

The Commission consists of representatives from the following engineering societies:

— American Society of Civil Engineers
— American Institute of Mining, Metallurgical, and Petroleum Engineers
— The American Society of Mechanical Engineers
— American Water Works Association
— Institute of Electrical and Electronics Engineers
— The American Society for Engineering Education
— American Society of Heating, Refrigerating, and Air-Conditioning Engineers
— American Society of Agricultural Engineers
— American Institute of Chemical Engineers
— Society of Fire Protection Engineers
— Society for Nondestructive Testing
— The Society of American Military Engineers
— The American Institute of Industrial Engineers
— American Institute of Consulting Engineers
— American Institute of Plant Engineers
— American Association of Cost Engineers
— American Society for Metals
— Instrument Society of America
— American Society for Quality Control
— National Institute of Ceramic Engineers
— Society of Women Engineers

TRENDS IN

ENGINEERING TECHNICIAN ENROLLMENTS AND GRADUATES

ENGINEERING MANPOWER COMMISSION
of Engineers Joint Council
345 East 47th Street
New York, New York 10017

July 1967

$2.00

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This report was prepared under the general direction of John Alden of the Engineering Manpower Commission staff. The analysis of the 1965-66 enrollment and graduate statistics was originally prepared by Dr. Donald Metz of Western Michigan University, a member of the Engineering Manpower Commission, and appeared in somewhat different form in the *Journal of Engineering Education,* February, 1967

Chapter Four, "Four-Year Engineering Technology Programs in Perspective," is based on a paper of the same title delivered by Dr. Harold A. Foecke, Dean of Engineering, Gonzaga University, at the Symposium on Engineering Technology of the NSF Summer Institute at the University of Houston, August 6, 1965, and since updated by the author.

Chapter Five, "An Evaluation of Baccalaureate Programs in Engineering Technology," by Jesse J. Defore, was originally given as a paper at the October 1966 meeting of the Engineers' Council for Professional Development, and is reprinted by permission of the author.

Chapter Six, "The Establishment of ECPD Accreditation for Baccalaureate Degree Programs in Engineering Technology," by Dr. Walter M. Hartung, was written especially for this report.

Tables and text were typed by Anne Howell and Carol Iceland of the Engineering Manpower Commission staff.

CONTENTS

Page

Introduction 3

Chapter 1 - Technician Enrollments and Graduates 1966 - 1967 8

Chapter 2 - Technician and Bachelors of Technology Enrollments and Graduates 1965 - 1966 15

Chapter 3 - Long Range Trends 27

Chapter 4 - Four-Year Engineering Technology Programs in Perspective, by Harold A. Foecke 34

Chapter 5 - An Evaluation of Baccalaureate Programs in Engineering Technology, by Jesse J. Defore 40

Chapter 6 - The Establishment of ECPD Accreditation for Baccalaureate Degree Programs in Engineering Technology, by Walter M. Hartung 49

Appendix 1 - A Selected Bibliography of Recent and Significant Publications Dealing with Technician Manpower 53

Appendix 2 - List of Responding Institutions 55

TABLES AND FIGURES

Figure 1 - Annual Salary as a Function of Years Since Graduation, 1966 6

Figure 2 - Projected Growth of Technician Employment, 1965 - 1976 7

Table I - Comparison of Enrollments and Graduates in Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum, 1964-65 to 1966-67 10

Table II - Results of 1966-67 Technician Enrollment Survey 11

Table III - Institutions, Enrollments, and Graduates by State, 1966-67 12

Table IV - Comparison of Enrollments and Graduates in Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum, 1965-66 and 1964-65 20

Table V - Summary of Enrollments and Graduates Reported By Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum for the Academic Year 1965-66 21

Table VI - Distribution by States of Institutions Reported as Offering Various Curriculums, and of Engineering Technician Enrollments and Graduates, 1965-66 22

Table VII - Summary of Enrollments and Graduates Reported by All Institutions Replying to Survey of Technicians for the Academic Year 1965-66 26

Table VIII - Engineering Technician Enrollments and Graduates in Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum, 1953 - 1967 30

continued on next page

CONTENTS (cont.)

Page

Table IX - Technicians, by Occupational Specialty, 1963 Employment and Projected 1975 Requirements 31

Table X - New Entrants from Post-secondary Preemployment Technician Training Programs, 1963-74 32

Table XI - Future Trends - Percent of Respondents Who Believe The Composition Of Technician Staffs Will Change As Indicated Over The Next Decade 33

Introduction

The Engineering Manpower Commission of Engineers Joint Council has long recognized the importance of the technician in the "engineering team." With graduate engineers in chronic short supply, and in view of an irresistible expansion of the formal engineering curriculum to encompass not only the explosive growth of new science and technology but also the pressing demand for a better understanding of the social sciences and humanities, a growing gap has developed between the functions of the highly educated professional engineer and those of the highly skilled mechanical trades. The engineering technician has become more and more important as the man whose job it is to fill this gap. Particularly we are concerned with the graduate of a formal technological curriculum of two or more years in duration.

In the technician, industry seeks an individual whose education includes enough scientific and theoretical background to enable him to appreciate why his activities are important and how they fit into the overall technological picture, and enough practical training to permit him to apply his knowledge quickly and efficiently to industrial problems. It is commonly said that the technician is an assistant to the engineer or scientist. However, he is more than an assistant. In many activities he is called upon to do things that engineers do not normally do, and he does many of them better than the average engineer could. The areas of detail design, drafting, test and inspection, maintenance, field service, and a host of others come to mind. Within the areas of his special expertise, the technician, on the basis of his education and experience, is frequently able to function in a limited, but effective, engineering capacity.

This point is illustrated by a recent survey of engineering technicians' salaries[1] conducted by the Engineering Manpower Commission of Engineers Joint Council in which it can be seen that technical school graduates achieve salaries well within the range of engineers' salaries, after ten or twelve years of experience. (See Figure 1.)

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[1] Salaries of Engineering Technicians, 1966. Engineering Manpower Commission of Engineers Joint Council, 345 East 47th Street, New York 10017. $5.00 prepaid.

Similarly, surveys[2/] show a demand for technical school graduates fully as strong as that for engineers. (See Figure 2.) In some areas, such as transportation, chemicals, and construction, the high rate of growth in technician employment is apparently due to the opening up of fields where few technicians were utilized in the past. In other industries, such as electronics, aerospace, and consulting, technicians already are filling a high ratio of jobs and can look forward to further growth in employment.

Because of the strong demand for technicians, EMC has recently taken a look at the supply picture. In 1965-66 and again in 1966-67, at the request of the American Society for Engineering Education, EMC surveyed all technical institutes and other schools known or believed to be offering curriculums in technology. The 1965-66 study also looked at several related areas where little statistical information is available. In particular, enrollments and graduations were reported in physical science technology, bachelor's degree programs in engineering and industrial technology, and non-terminal pre-engineering programs from which students presumably transfer into regular engineering schools. The results of this survey are given in Chapter 2.

Chapter 1 covers the 1966-67 survey of enrollments and graduates in the traditional engineering and industrial technology programs only, while Chapter 3 compares the growth in these fields since 1953 and looks at long range trends in technician employment.

The significance of the rapidly growing four-year bachelor's degree program in engineering technology is analyzed by three eminently qualified educators in the last three chapters of this report.

[2/] Demand for Engineers and Technicians, 1966. Engineering Manpower Commission of Engineers Joint Council, 345 East 47th Street, New York 10017. $4.00 prepaid.

In Chapter 4 Dr. Harold A. Foecke, Dean of Engineering at Gonzaga University discusses the place of these programs in the engineering spectrum.

Jesse J. Defore, former Dean of Technologies and Skills at Lake Michigan College and now Vice President of Seattle Community College, gives his evaluation of these programs in Chapter 5.

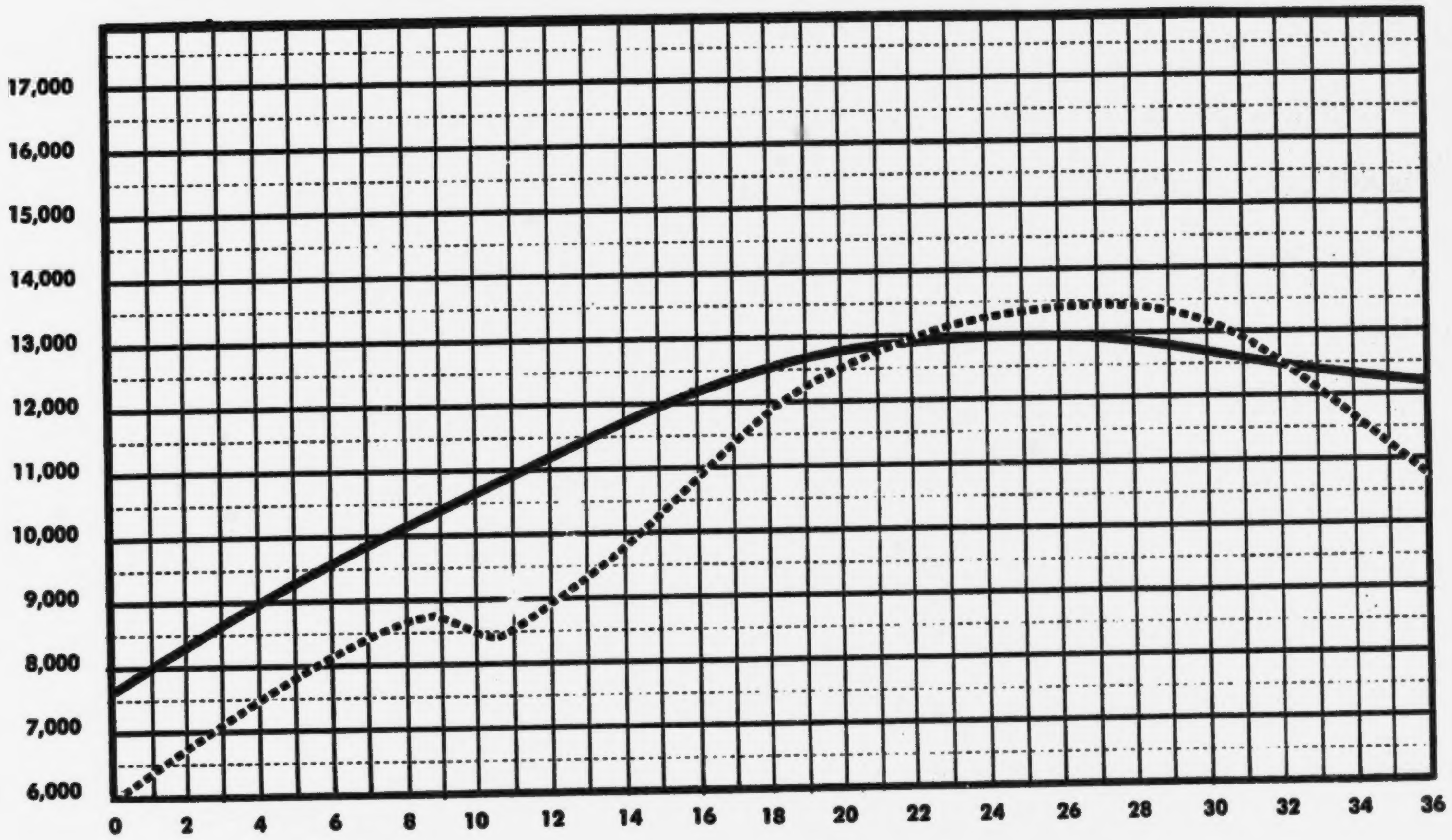
Finally, in Chapter 6, Dr. Walter M. Hartung, President of the Academy of Aeronautics, brings us up to date on plans of the Engineers' Council for Professional Development for accreditation of four-year bachelor's degree curricula in engineering technology.

Appendix 1 includes a special bibliography of literature on technicians for those who are interested in a deeper study of this subject.

Appendix 2 lists the institutions that responded to the EMC surveys of technician enrollments and graduates. It should be noted that this is not a complete list of all institutions offering technician programs, but it does include all of those with curricula currently accredited by ECPD.

Figure 1

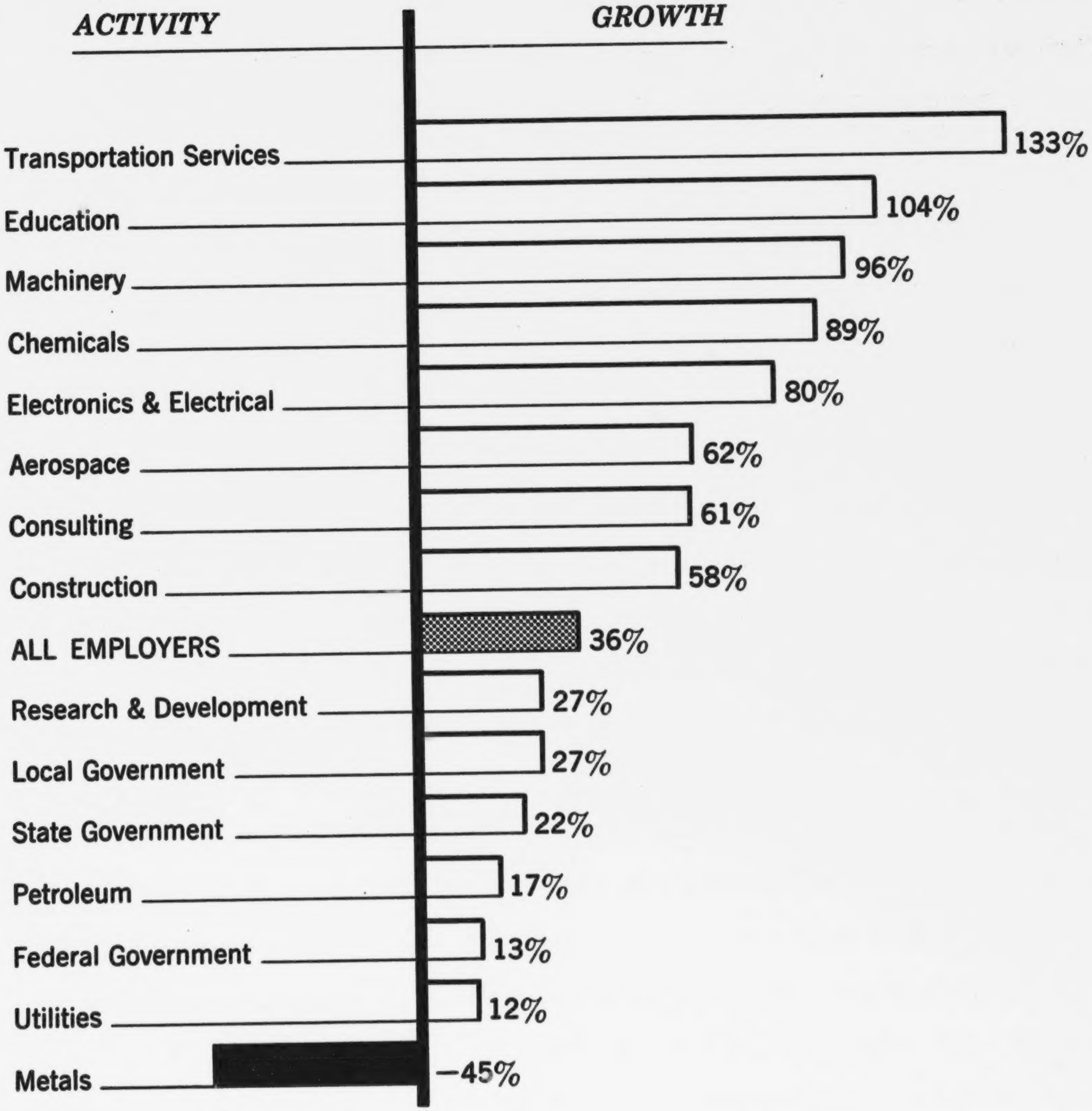
Annual Salary as a Function of Years Since Graduation
1966



Legend: Engineers, lower quartile ━━━━━━
Graduate Technicians, median ┈┈┈┈┈┈

Figure 2

PROJECTED GROWTH OF TECHNICIAN EMPLOYMENT, 1965–1976



Chapter 1

Technician Enrollments and Graduates 1966 - 1967

The 1966-67 Survey

This twelfth survey of technician enrollments and graduates included only the two categories of technicians, engineering and industrial, covered by the earlier American Society for Engineering Education surveys dating back to 1953-54. The following definitions were given in the instruction sheet accompanying each questionnaire:

> Engineering Technicians - students in engineering oriented organized occupational curriculums of at least two (2) but less than four (4) years, leading to Associate degree or similar designation.
>
> Industrial Technicians - students in skill oriented organized occupational curriculums of at least one (1) year.

As in earlier surveys, only the data for ECPD-accredited institutions show sufficient accuracy and consistency to permit year-to-year comparisons. The 1966 ECPD list of institutions included 38 schools with at least one accredited engineering technology program. (The Pennsylvania State University is counted as a single institution in this total.) All 38 schools furnished data for 1966-67. Enrollments are as of about October 1, 1966, and graduates are estimated for the school year 1966-67. Full-time enrollments in these institutions ranged from a high of 2214 to a low of 31, while the largest number of graduates reported was 875, and the lowest was 9. Table I presents the comparison between the figures for the ECPD-accredited schools for the last three years.

Table II gives the 1966-67 data by type of institution (ECPD-accredited or otherwise) and by curriculum (engineering or industrial technology). This shows that the 38 ECPD schools have about 37% of the full-time engineering technician enrollments and 37% of the graduates, but only 15% of the industrial technician enrollments and graduates. The figures for the non-accredited schools cannot be compared with earlier surveys because of differences in the institutions responding to each year's survey and the rapid growth being experienced in the number of schools offering technology programs. The high ratio of new to total enrollments is also an indication of the increased popularity of these curriculums.

Distribution by State

The breakdown of replies by state for all respondents to this year's survey, ECPD-accredited and non-accredited combined, is given in Table III. New York again leads in the number of technician graduates, followed by California, Massachusetts, and Pennsylvania. Note that these figures should not be construed as representing the actual number of enrollments or graduates in any state, as there are many schools that did not respond to this survey.

Some idea of the inconsistency in the definition of programs, particularly in the industrial technician area, can be gained by comparing the ratios of graduates to full-time enrollments. In a few states more graduates are reported than full-time enrollments. To some extent this may be due to large numbers of graduates from part-time students. If so, this is a phenomenon limited to certain states or localities, as may be seen from the national figures given in Table II where for all institutions engineering technician graduates number about 21% of total enrollments, while the ratio for industrial technicians is 32%. It is obvious that much effort must be made to gather and analyze data on technician enrollments and graduations before meaningful statistics can be developed. This survey is only a start in the right direction.

TABLE I

Comparison of Enrollments and Graduates in Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum 1964-65 - 1966-67

Academic Year	Engineering Technician Enrollments	Graduates
	FULL-TIME	
1964-65	19,697	5,693
1965-66	20,156	4,995
1966-67	19,639	5,808
	PART-TIME	
1964-65	4,631	336
1965-66	4,388	275
1966-67	4,865	336
	TOTAL FULL-TIME AND PART-TIME	
1964-65	24,328	6,029
1965-66	24,544	5,270
1966-67	24,504	6,144

1966-67 figures should be reduced by 48 full-time enrollments, 12 full-time graduates, and 16 part-time enrollments to be fully comparable with the earlier years in terms of coverage of the same institutions.

TABLE II

Results of 1966-67 Technician Enrollment Survey

Type of Institution and Curriculum	Full-Time Students			Part-Time Students			All Students		
	Fall Term 1966 Enrollments		Graduating 1966-67	Fall Term 1966 Enrollments		Graduating 1966-67	Fall Term 1966 Enrollments		Graduating 1966-67
	New	Total	(Estimated)	New	Total	(Estimated)	New	Total	(Estimated)
ECPD Accredited									
Engineering Tech.	10,148	19,639	5,808	1,620	4,865	336	11,768	24,504	6,144
Industrial Tech.	2,211	4,055	1,679	1,803	2,907	382	3,294	6,962	2,061
Non-Accredited									
Engineering Tech.	18,401	32,953	8,616	9,977	22,359	1,685	28,378	55,312	10,301
Industrial Tech.	12,655	22,958	8,389	5,988	13,280	3,302	18,643	36,238	11,691
All Institutions									
Engineering Tech.	28,549	52,592	14,424	11,597	27,224	2,021	40,146	79,816	16,445
Industrial Tech.	14,866	27,013	10,068	7,071	16,187	3,684	21,937	43,200	13,752

TABLE III

Institutions, Enrollments, and Graduates by State, 1966-67

State	Engineering Technicians			Industrial Technicians		
	Number of Institutions	Full-Time Enrollments	Total Graduates	Number of Institutions	Full-Time Enrollments	Total Graduat
Alabama	6	310	86	1	54	9
Alaska	0	0	0	1	74	23
Arizona	5	748	102	2	102	23
Arkansas	1	58	43	2	30	28
California	43	3,862	1,084	27	3,988	1,359
Colorado	6	602	276	2	53	53
Connecticut	6	1,656	542	1	116	48
Delaware	0	0	0	0	0	0
Florida	15	1,650	419	5	462	105
Georgia	6	1,383	437	4	839	510
Hawaii	1	23	0	0	0	0
Idaho	3	166	64	2	261	116
Illinois	15	2,887	877	10	1,727	1,044
Indiana	1	373	100	0	0	0
Iowa	9	692	224	4	135	67
Kansas	2	87	30	3	605	67
Kentucky	4	127	35	2	220	112
Louisiana	3	515	96	1	67	21
Maine	0	0	0	1	401	181
Maryland	4	210	54	1	50	10
Massachusetts	10	3,522	1,758	4	1,002	612
Michigan	12	2,487	619	11	1,370	606
Minnesota	8	511	137	7	359	180

TABLE III (Cont.)

State	Engineering Technicians			Industrial Technicians		
	Number of Institutions	Full-Time Enrollments	Total Graduates	Number of Institutions	Full-Time Enrollments	Total Graduate
Mississippi	7	556	104	3	620	1,141
Missouri	9	724	160	8	657	295
Montana	2	67	15	1	6	0
Nebraska	0	0	0	1	660	355
Nevada	1	71	7	0	0	80
New Hampshire	1	226	75	1	215	81
New Jersey	6	460	191	3	479	297
New Mexico	3	212	56	1	45	18
New York	27	9,497	3,138	9	2,004	725
North Carolina	14	1,766	584	13	978	964
North Dakota	3	44	26	0	0	0
Ohio	18	2,804	821	2	316	115
Oklahoma	5	552	214	2	714	504
Oregon	6	1,032	350	5	832	1,137
Pennsylvania*	24	4,183	1,452	7	2,214	626
Rhode Island	2	372	90	1	107	0
South Carolina	3	556	142	3	223	171
South Dakota	2	81	36	2	178	73
Tennessee	1	189	50	3	755	63
Texas	12	2,387	511	6	450	129
Utah	4	250	86	6	559	252
Vermont	1	276	93	0	0	0
Virginia	6	983	273	3	212	125
Washington	11	439	154	4	261	122
West Virginia	2	238	38	2	238	38

TABLE III (Cont.)

State	Engineering Technicians			Industrial Technicians		
	Number of Institutions	Full-Time Enrollments	Total Graduates	Number of Institutions	Full-Time Enrollments	Total Graduates
Wisconsin	14	2,449	689	14	2,339	1,267
Wyoming	1	5	2	0	0	0
Dist. of Columbia	1	314	95	0	0	0
Total	346	52,592	16,445	191	27,013	13,752

* Includes 12 centers of The Pennsylvania State University counted individually.

Chapter 2

TECHNICIAN AND BACHELORS OF TECHNOLOGY ENROLLMENTS AND GRADUATES
1965 - 1966

THE 1965-66 SURVEY

The eleventh survey of technician enrollments and graduates was undertaken by the Engineering Manpower Commission in 1966 at the request of the American Society for Engineering Education. It covered three types of technicians, pre-engineering students, and two bachelor of technology groups. The instruction sheet accompanying each questionnaire included the following definitions for guidance in reporting:

> *Engineering Technicians* - students in *engineering oriented* organized occupational curriculums of at least two (2) but less than four (4) years, leading to an Associate degree or similar designation.
>
> *Physical Science Technicians* - students in *physical science and mathematics oriented* organized occupational curriculums of at least two (2) but less than four(4) years, leading to Associate degree or similar designation. (Do not include Medical or Dental Technicians or others not directly related to the physical sciences.)
>
> *Industrial Technicians* - students in *skill oriented* organized occupational curriculums of at least one (1) year.
>
> *Pre-Engineering* - students in curriculums of at least two (2) years, leading to transfer to an engineering school for completion of a Bachelor's degree in engineering. *To be reported only where the reporting institution itself does not award Bachelor's degrees in engineering*.
>
> *Bachelor of Technology* - students in *engineering or technically oriented* curriculums leading to a Bachelor's degree in technology but *not to a recognized degree* in engineering. Separate categories are provided for engineering technology and industrial technology curriculums.

ENGINEERING TECHNICIANS IN ECPD ACCREDITED INSTITUTIONS

Because of variations in the institutions responding to this survey from year to year, valid comparisons are possible only for engineering technicians in institutions with at least one ECPD accredited engineering technology curriculum. This is done in Table IV. Only those data for full-time enrollments and graduates have a reasonable degree of accuracy and consistency. The 1965 ECPD list of institutions included 37 schools with at least one accredited Engineering Technology program. All of these furnished data for 1964-65 and 1965-66. (The Pennsylvania State University is counted as one institution although 14 Centers reported.) Enrollments were as of about October 1, 1965, and graduates were estimated for the school year 1965-66.

The range of enrollments and graduates of ECPD schools shows considerable variation. Full-time enrollments ranged from a high of 2321 to a low of 22, while the largest institution reported 830 graduates and the smallest reported none as graduated from engineering technology programs in 1965-66.

It is of interest to note that the 37 ECPD schools accounted for nearly 39% of the full-time engineering technician enrollments and 43% of the graduates reported by all respondents to this survey.

OTHER PROGRAMS IN ECPD ACCREDITED INSTITUTIONS

Table V shows the number of ECPD institutions reporting data for all types of programs included in the survey, as well as totals for each category. Of the 37 institutions responding, 15 reported offering only engineering technology programs. Three schools offer physical science technician curriculums; nine have programs for industrial technicians; while seven transfer students to engineering schools from pre-engineering studies. Finally, only four schools have bachelor's degree programs in engineering technology, and none offer bachelor's degree programs in industrial technology.

Despite the small number of schools involved in any of the other categories, industrial technicians account for about 27% of the graduates from these institutions but only 17% of the full-time enrollments. They also show a higher ratio of part-time to full-time students than do the engineering and physical science technician curriculums. It is apparent that the industrial technology curriculums are of shorter duration than the others, as evidenced by a higher ratio of graduates to enrollments. It is interesting to note that engineering technician graduates are about one fourth of the total enrolled, considering only full-time figures. This can only be accounted for by a curriculum which is longer than the nominal two years traditionally associated with the technical institutes, or by a high rate of attrition during the course of study. Most likely it is a combination of both. Either cause would provide a basis for confidence in the soundness of the education being provided in these curriculums. The ratio of industrial technician graduates to enrollments is much higher, about 40%. This is consistent with an actual curriculum of two years or less, as expected.

The bachelor of technology figures represent a new facet of technological education. Apparently these curriculums have found only limited acceptance in the ECPD accredited technical institutes, with only four schools reporting them. It is believed that more than 70 institutions now offer bachelor of technology degrees. Because they are not yet a significant factor in the ECPD accredited schools, they will be discussed elsewhere in this report.

Finally, the pre-engineering students are worthy of some explanation. These are non-terminal curriculums in that they do not normally lead to a degree at the two-year point. Presumably these students are preparing for transfer to regular 4-year colleges, possibly under formal co-operative programs. The ECPD schools account for about one third of all such students reported in this survey. There is no doubt but that these students are an important input into the regular engineering enrollment statistics, especially at the junior year. Attrition in engineering students is abnormally low from the junior to the senior year unless an input from outside sources is postulated. The absolute numbers identified in this survey are probably only a fraction of the total of transfer students, because no effort was made to contact the many four-year colleges which, although they do not award engineering degrees, do give pre-engineering courses. Graduates who originally came from these unconventional sources are, of course, already included in educational statistics and do not constitute a hidden source of manpower. They could, however, represent the beginnings of a shift in educational patterns for engineers, with the established engineering schools becoming more like graduate institutions and drawing an increasing proportion of their students from "feeder" sources. It is apparent that much more needs to be found out about these pre-engineering programs before conclusions can be drawn about them or even their actual numbers can be determined.

DISTRIBUTION BY STATE

Table VI shows the distribution by states of all institutions (ECPD accredited or otherwise) offering various programs. In addition, engineering technician enrollments and graduates are indicated. For these latter data, the top figures in each row are full-time with the bottom row being part-time students and graduates.

New York leads in the number of full-time enrollments and graduates, but Massachusetts, in second place, is ahead of many more populous states and also shows an unusually high number of part-time technician enrollments. California has the most schools, but ranks only seventh in full-time enrollments. Considered as sources of graduate technicians, the 10 leaders, which together accounted for 71% of all graduates, were:

New York	2,117
Massachusetts	1,678
Pennsylvania	1,003
Wisconsin	677
Illinois	657
California	608
New Jersey	544
Ohio	514
Connecticut	469
Georgia	459

In using these figures it must be observed that these represent only those schools that answered our survey and do not purport to be total technician enrollment and graduate figures for the United States.

SUMMARY FIGURES FOR ALL PROGRAMS

Table VII is a summary of replies received from 504 institutions. This shows enrollments and estimated graduates for the several types of programs covered by the questionnaire.

As previously noted, the bachelor of technology programs are largely in the non-ECPD accredited schools. If there are more than 70 schools currently awarding these degrees, this survey succeeded in obtaining responses from less than half of them. Even so, it has disclosed the existence of more than 1100 such graduates in 1965-66. Compared to 34,000 graduates with bachelor's degrees in engineering being produced each year, this is not a large number. Even if there are actually twice as many bachelors of technology, they represent a group only one-sixteenth as large as the engineering graduates. However, when it is recalled that about 26% of the engineering graduates stay in school for advanced degrees, and perhaps 8% go into the armed forces, it appears that the technology graduates may constitute as much as 10% of the supply of college graduates available for immediate employment. In view of continued shortages of technologically educated manpower and the growing number of engineering technology curriculums being offered, it seems obvious that the technology graduates will become more and more of a factor in the recruiting and employment picture. Where and how they will fit into the engineering team is a great unanswered question, and one that will be the subject of much interest in the years to come.

TABLE IV

Comparison of Enrollments and Graduates in Institutions Having At Least One ECPD Accredited Engineering Technology Curriculum
1965-66 and 1964-65

Academic Year	Engineering Technician Enrollments	Graduates
	FULL-TIME	
1965-66	20,156	4,995
1964-65	19,697	5,693
	PART-TIME	
1965-66	4,388	275
1964-65	4,631	336
	TOTAL FULL-TIME AND PART-TIME	
1965-66	24,544	5,270
1964-65	24,328	6,029

Note:
1964-65 Figures Adjusted for Changes in Institutions as Reported by ECPD in October, 1965.

TABLE V

Summary of Enrollments and Graduates Reported By Institutions Having at Least One ECPD Accredited Engineering Technology Curriculum for the Academic Year 1965-66

Categories	No. of Insts.	ENROLLMENTS Fall Semester, 1965-66 Full-Time	Part-Time	Total	GRADUATES, 1965-66 Estimated Full-Time	Part-Time	Total
Engineering Technicians	37*	20,156	4,388	24,544	4,995	275	5,270
Phys. Sci. Technicians	3	439	2	441	119	1	120
Industrial Technicians	9	4,254	1,590	5,844	1,674	327	2,001
Bach. of Engr. Tech. Students	4	294	100	394	88	---	88
Bach. of Indust. Tech. Students	0	------	-----	-------	-----	---	-----
Pre-Engineering Students	7	1,690	362	2,052	136	10	146

* The Pennsylvania State University counted as one institution includes reports on 14 centers

T A B L E VI

Distribution by States of Institutions Reported as Offering Various Curriculums, and of Engineering Technician Enrollments and Graduates, 1965-66.

		INSTITUTIONS REPORTING EACH TYPE CURRICULUM						ENGINEERING TECHNICIANS*	
	TOTAL NUMBER REPORTING	ENGINEERING TECHNICIANS	PHYSICAL SCIENCE TECHNICIANS	INDUSTRIAL TECHNICIANS	PRE-ENGINEERING STUDENTS	BACHELOR OF ENGR. TECH. STUDENTS	BACHELOR OF INDUST. TECH. STUDENTS	ENROLLMENTS	GRADUATES
All States & Puerto Rico	504	327	53	196	272	17	28	52,252* 21,345	10,459 1,785
Alabama	12	7	1	2	9	--	1	162 -----	33 ---
Alaska	--	--	--	--	--	--	--	-----	---
Arizona	4	4	1	--	3	--	1	87 20	--- ---
Arkansas	1	--	--	--	1	--	--	-----	---
California	44	32	5	25	32	2	2	2,868 984	510 98
Colorado	6	4	1	1	4	--	--	429 40	74 8
Connecticut	6	5	1	1	--	--	--	1,727 1,420	410 59
Delaware	1	--	--	--	1	--	--	-----	---
D. C.	1	1	--	--	--	1	--	369 280	71 7
Florida	22	15	2	7	17	1	--	1,508 337	220 13
Georgia	13	8	1	4	3	--	--	1,457 404	421 38
Hawaii	1	1	--	--	--	--	--	18 -----	1 ---
Idaho	5	4	1	2	2	--	--	283 -----	9 ---
Illinois	26	19	6	11	17	1	3	3,207 502	62 2

TABLE VI (cont.)

		INSTITUTIONS REPORTING EACH TYPE CURRICULUM						ENGINEERING TECHNICIANS*	
	TOTAL NUMBER REPORTING	ENGINEERING TECHNICIANS	PHYSICAL SCIENCE TECHNICIANS	INDUSTRIAL TECHNICIANS	PRE-ENGINEERING STUDENTS	BACHELOR OF ENGR. TECH. STUDENTS	BACHELOR OF INDUST. TECH. STUDENTS	ENROLLMENTS	GRADUATES
Indiana	4	2	1	3	1	1	1	778 567	176 ---
Iowa	11	8	--	3	4	1	--	655 95	223 ---
Kansas	14	3	1	9	11	1	3	112 -----	5 ---
Kentucky	7	1	--	4	4	--	--	----- 6	--- ---
Louisiana	1	--	--	--	--	--	1	-----	---
Maine	1	--	--	1	--	--	--	-----	---
Maryland	9	4	--	2	8	--	--	198 114	19 6
Massachusetts	16	12	2	4	5	1	1	5,397 5,214	1,135 543
Michigan	18	13	3	9	13	2	2	3,539 1,244	281 29
Minnesota	17	3	2	9	8	--	--	266 10	119 1
Mississippi	10	4	1	7	9	--	1	99 8	18 ---
Missouri	14	9	--	8	11	--	--	679 168	136 16
Montana	3	1	1	2	3	--	--	50 6	--- ---
Nebraska	3	1	--	1	1	--	--	190 79	27 ---
Nevada	2	1	--	1	--	--	--	126 -----	New '65 ---
New Hampshire	1	1	--	--	--	--	--	203 8	31 ---

TABLE VI (cont.)

		INSTITUTIONS REPORTING EACH TYPE CURRICULUM.						ENGINEERING TECHNICIANS*	
	TOTAL NUMBER REPORTING	ENGINEERING TECHNICIANS	PHYSICAL SCIENCE TECHNICIANS	INDUSTRIAL TECHNICIANS	PRE-ENGINEERING STUDENTS	BACHELOR OF ENGR. TECH. STUDENTS	BACHELOR OF INDUST. TECH. STUDENTS	ENROLLMENTS	GRADUATES
New Jersey	8	6	1	2	1	--	--	503 1,824	372 172
New Mexico	5	4	--	1	3	--	1	129 53	20 7
New York	34	25	4	9	24	--	--	9,195 1,474	1,841 276
N. Carolina	19	14	3	11	5	--	--	1,607 639	398 18
N. Dakota	2	1	--	1	2	--	--	84 -----	29 ---
Ohio	19	16	2	2	3	1	2	2,062 1,326	427 87
Oklahoma	10	7	1	3	5	--	1	1,171 423	210 38
Oregon	9	8	1	6	2	--	--	1,072 121	251 17
Pennsylvania	32+	21	3	7	13	--	--	3,363 1,671	845 158
Rhode Island	3	2	--	1	1	--	--	158 50	29 10
S. Carolina	4	4	--	3	--	--	--	797 75	217
S. Dakota	2	1	--	1	--	--	--	16 -----	--- 4
Tennessee	8	2	1	2	4	--	3	84 100	--- 9
Texas	21	13	1	7	15	2	1	2,203 192	124 26
Utah	6	2	1	3	1	1	3	129 132	43 14
Vermont	1	1	--	--	--	--	--	234 -----	82 ---

TABLE VI (cont.)

	TOTAL NUMBER REPORTING	INSTITUTIONS REPORTING EACH TYPE CURRICULUM						ENGINEERING TECHNICIANS*	
		ENGINEERING TECHNICIANS	PHYSICAL SCIENCE TECHNICIANS	INDUSTRIAL TECHNICIANS	PRE-ENGINEERING STUDENTS	BACHELOR OF ENGR. TECH: STUDENTS	BACHELOR OF INDUST. TECH. STUDENTS	ENROLLMENTS	GRADUATES
Virginia	13	6	--	4	8	1	--	1,164 210	147 9
Washington	15	10	2	8	10	--	--	366 212	101 42
W. Virginia	2	2	--	--	1	--	--	131 1	25 ---
Wisconsin	24	17	3	9	4	--	1	3,255 1,279	635 42
Wyoming	3	1	--	--	3	1	--	35 -----	7 ---
Puerto Rico	1	1	--	--	--	--	--	107 57	20 10

* Top Figure in Each Row is for Full-Time Students, and Bottom Figure is for Part-Time Students.

+ 14 Pennsylvania State University Centers Included in this Number.

TABLE VII

Summary of Enrollments and Graduates Reported by All Institutions Replying to Survey of Technicians for the Academic Year 1965-66.
(Based on 504 Replies)

Categories	No. of Insts.	ENROLLMENTS Fall Semester, 1965-66			GRADUATES, 1965-66 Estimated		
		Full-Time	Part-Time	Total	Full-Time	Part-Time	Total
Engineering Technicians	327	52,252	21,345	73,597	10,459	1,785	12,244
Phys. Sci. Technicians	53	2,448	858	3,306	360	33	393
Industrial Technicians	196	22,508	21,568	35,076	8,871	1,044	9,915
Bach. of Engr. Tech. Students	17	2,501	166	2,667	263	1	264
Bach. of Indust. Tech. Students	28	4,070	3,612	7,682	633	246	879
Pre-Engineering Students	272	25,176	6,895	32,171	2,523	400	2,923*

* Number of students completing non-terminal course leading to transfer to regular engineerin schools.

Chapter 3

LONG RANGE TRENDS

Table VIII shows the results of surveys since 1953. To provide a reasonably secure basis for comparison, only the figures for engineering technicians in ECPD-accredited institutions are given. On the basis of these figures, little overall change is noticeable over the past ten years. Until 1959 there was a gradual rise in enrollments, resulting in a graduate peak of 7,639 in 1960. Since then the situation has been almost static. A slight increase in 1965-66 enrollments was reflected in more graduates a year later, but the latest enrollment figures portend another decrease next year.

It is therefore evident that the major growth in technician education continues to be in the area of industrial technician curriculums and in schools that are not accredited by ECPD.

In contrast to the rather discouraging picture presented above, which represents the supply side of the supply-demand equation, the demand for qualified engineering technicians shows no signs of abating. The Bureau of Labor Statistics of the U.S. Department of Labor estimates that technician employment will increase by 77% from 1963 to 1975, and that 1,495,000 technicians of all types will be employed in 1975. Engineering technicians make up the largest category, as indicated in Table IX. Industry groups expected to show higher than average growth include construction, engineering and architectural services, education, chemicals and allied products, rubber products, and scientific instruments. Government agencies are also expected to demand a greater share of technicians.

The annual average of technician requirements for the period 1963-1975 is put at 86,000, of whom 54,000 are needed to fill new positions, 10,000 to replace deaths and retirements, and 22,000 to make up for transfer losses. It is apparent that a demand of this magnitude is not likely to be met by established technical schools at present enrollment and graduation rates, even making allowance for the students in schools that did not respond to the EMC surveys. Table X shows the BLS projections of enrollments and graduations from 1962 to 1973.

It is interesting to note that the BLS figures for 1966-67 are 178,300 enrollments and 50,800 graduates, compared with 123,000 total full-and part-time enrollments and 30,200 graduates reported to EMC. The difference is probably explained by students in drafting, life science technician, and miscellaneous curriculums. These first two groups constituted 34% of the 1963 technician employment (see Table IX) and probably make up a similar percentage of enrollments and graduates.

BLS notes that the major traditional source of technicians in industry has been personnel upgraded from other occupations. However, this is becoming a less satisfactory method as the complexity of technical work increases and formal educational requirements become more stringent. Therefore BLS feels that upgrading will decline in importance and that only about 28% of the 1963-74 requirement will be met from this source. Other sources include MDTA programs, college graduates and dropouts, and armed forces separations, but none of these are expected to provide large numbers of technicians.

Figure 2 in the introduction to this report showed how the demand for technicians appeared in EMC's own survey of 1966. Other findings presented in Table XI indicated that employers expect the ratio of technicians to engineers and scientists to increase, the number of technicians trained in-house to increase, and the proportion of technical institute graduates among new technician hires to increase.

All in all, the tide seems to be running strongly in favor of increased opportunities for graduate technicians but the supply shows signs of lagging. Perhaps of even greater concern is the faster rate of growth in schools which have no ECPD accredited curriculums. Since these represent a highly variable set of programs with little or no standardization of course content, quality, or nomenclature, their impact could create a great deal of confusion among students, employers, and recruiters in the next few years. Educators in the engineering technology field will have to exercise unusual vigilance to insure that the standards and reputation of their established programs are not jeopardized, either in actuality or in appearance, during this period of great flux in the education and utilization of the technician.

TABLE VIII

Engineering Technician Enrollments and Graduates in Institutions Having at Least One ECPD-Accredited Engineering Technology Curriculum

1953 - 1967

	Number of Institutions Reporting	ENROLLMENT			GRADUATES		
		Full Time	Part Time	Total	Full Time	Part Time	Total
1953-54	27	7,895	9,451	17,346	2,662	1,265	3,927
1954-55	27	9,914	7,561	17,475	3,511	854	4,365
1955-56	29	13,179	11,558	24,737	4,461	1,038	5,499
1956-57		NO SURVEY THIS YEAR					
1957-58	35	16,606	5,641	22,247	5,385	543	5,928
1958-59	35	17,554	6,814	24,386	5,809	669	6,478
1959-60	34	17,852	8,482	26,334	6,471	1,168	7,639
1960-61	33	16,438	7,370	23,808	5,601	683	6,284
1961-62	32	17,090	7,401	24,491	5,369	666	6,035
1962-63	32	16,909	4,924	21,833	5,095	394	5,489
1963-64	32	16,658	5,060	21,718	4,882	625	5,507
1964-65	33	18,328	5,913	24,241	5,239	459	5,695
1965-66	37	20,156	4,388	24,544	4,995	275	5,270
1966-67	38	19,639	4,865	24,504	5,808	336	6,144

TABLE IX

Technicians, by Occupational Specialty, 1963 Employment and Projected 1975 Requirements

Occupation	1963 employment	Projected 1975 requirements	Percent increase, 1963-75
Technicians, all occupations	844,800	1,495,000	77
Draftsmen	232,000	375,000	62
Engineering and physical Science technicians	439,000	765,000	74
Engineering technicians	308,500	533,000	73
Chemical technicians	64,600	122,000	89
Physics technicians	10,800	22,000	104
Mathematics technicians	6,100	12,000	97
Other physical science technicians	49,000	81,000	65
Life science technicians	58,100	139,000	139
Other technicians	115,700	210,000	82

Note: Because of rounding the sum of individual items may not add to totals.
Source: U. S. Department of Labor

TABLE X

New Entrants from Post-secondary Preemployment Technician Training Programs, 1963-74

Academic year	Number enrolled	Number graduating	Number entering technician occupations
1962-63	90,700	24,900	16,200
1963-64	99,900	27,500	17,900
1964-65	119,800	32,900	21,400
1965-66	153,000	42,800	27,800
1966-67	178,300	50,800	33,000
1967-68	191,600	55,600	36,100
1968-69	206,300	60,900	39,600
1969-70	222,900	66,900	43,500
1970-71	230,200	70,200	45,600
1971-72	240,100	74,400	48,400
1972-73	249,200	78,500	51,000
1973-74	257,100	82,300	53,500
Total 1973-74	2,239,000	667,700	434,000
Annual average	186,600	55,600	36,200

Note: Because of rounding the sum of individual items may not equal totals.

Source: U. S. Department of Labor

TABLE XI

FUTURE TRENDS

Percent Of Respondents Who Believe The Composition Of Technician Staffs Will Change As Indicated Over The Next Decade

ACTIVITY (1)	The Proportion of Technicians to Engineers and Scientists Will			The Number of Technicians Trained By Your Organization Will			The Proportion of New Hires Who Are Technical Institute Graduates Will		
	Increase	Stay the Same	Decrease	Increase	Stay the Same	Decrease	Increase	Stay the Same	Decrease
All Respondents	62%	35%	4%	70%	25%	5%	81%	16%	3%
All Industry	68	31	1	68	30	2	91	9	*
Aerospace	65	35	*	84	16	*	98	2	*
Chemical	97	3	*	43	57	*	97	*	3
Construction	34	63	3	46	54	*	47	53	*
Consulting	45	54	1	74	26	*	80	20	*
Electronics-Electrical	96	3	1	96	4	*	98	2	*
Machinery	72	23	5	65	35	*	82	18	*
Metals	94	5	*	15	85	*	91	9	*
Misc. Mfg.	36	64	*	76	8	16	69	28	4
Petroleum	71	29	*	29	71	*	99	1	*
Research & Development	3	90	7	14	86	*	76	24	*
Transportation Services	63	34	3	79	18	3	40	60	*
Utilities	79	20	*	79	14	7	83	16	*
All Government	52	41	8	73	16	11	60	31	9
Federal Government	30	69	1	82	18	*	35	65	*
State Government	64	24	12	69	12	19	81	*	19
Local Government	40	57	3	44	54	2	70	30	*
Education	70	27	3	77	15	8	85	15	*

(1) All replies weighted in proportion to numbers of technicians employed.

* Less than 1%

Note: Individual percentages may not total 100% due to rounding.

Chapter 4

FOUR-YEAR ENGINEERING TECHNOLOGY PROGRAMS IN PERSPECTIVE [1]

Harold A. Foecke
Dean of Engineering
Gonzaga University

Introduction

The four-year program leading to a bachelor's degree in engineering technology represents a development in American higher education which could have a most revolutionary kind of impact on both engineering education and technical education. Consequently, I am honored to be involved in a consideration of this subject.

Before getting underway, let me indicate my own relation to this topic. My interest in the subject is not personal; I am not necessarily an advocate of such programs. We have no engineering technology programs at my institution, nor have there been any serious discussions about establishing any, which also means it hasn't been explicitly excluded as a future possibility.

Rather, my interest springs from the possible impact which this budding development could have on my own field of research and scholarship, which is the system of engineering education in this country. In fact, it was while serving as Specialist for Engineering Education with the U. S. Office of Education that I first became aware of the existence and potentialities of four-year technology programs and I have tried to monitor developments in this area ever since. Hence, my posture is the neutral one of the commentator or reporter; I am neither an advocate or critic of these programs.

My paper has three basic parts: (a) a review of a few relevant facts, not gathered by any organized survey, (b) a summary of some of the arguments I have heard both for and against four-year engineering technology programs, and (c) an attempt to place these programs in perspective by showing how they could relate to emerging programs in adjoining areas (engineering and engineering science).[2]

Review of the Current Setting

It is a bit difficult to know where to start and stop in a review of the facts which seem to have relevance. Let me begin by noting that from Dr. Russell Riese, Associate Dean of Academic Planning for the California State College System, I learned that a survey made by his office disclosed 64 institutions with bachelor's degree programs in some area of technology, as defined by his survey methods. This figure is confirmed in a general way by a document, prepared under the direction of Dean Hugh E. McCallick of the College of Technology of the University of Houston, which reports that "at least sixty institutions in the United States are now offering four-year degree programs in technology." 3/

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[1] Based on a paper presented on June 23, 1965, at the 73rd Annual Meeting of the American Society for Engineering Education held at the Illinois Institute of Technology in Chicago.

[2] For a paper by the author dealing with additional aspects of the topic of four-year engineering technology programs, the reader may request from the American Society for Engineering Education (1346 Connecticut Avenue, N.W.; Washington, D. C. 20036) a copy of the set of three papers on this subject presented by different speakers at the October 1966 meeting of the Engineers' Council for Professional Development.

Apparently these five dozen or more programs fall into roughly two groups--those which have evolved from an industrial arts heritage (most frequently called "industrial technology" programs by the institutions involved) and a much smaller number which have been related to an engineering tradition (and which are usually called "engineering technology" programs). I do not pretend to know the names of all of the institutions with bachelor's degree programs in engineering technology, but I do know some that are in existence, a couple that are being launched, and several more that are in the active planning stage.

At the two-year level, as many of you are aware, there has been a sharp increase in the number of technology programs since 1958, due largely to the Federal funds available through Title VIII of the National Defense Education Act. Many of these programs have evolved out of a vocational education background, which is considerably different from either the industrial arts or engineering backgrounds previously mentioned.

Also relevant in my opinion is the marked increase in the fractions of engineering graduates that are going on for further formal education. In spite of the fact that the numbers of bachelor's degrees in engineering have not increased in proportion to increases in higher education as a whole (and, in fact, during 1964-5, the last year for which we have data, the number was well below the peak of 1958-9), the number of master's degrees in engineering has more than doubled in less than a decade. Doctor's degrees in engineering have been climbing even more sharply, doubling in the last four years and tripling in the last seven prior to 1965.

Another relevant point is the roughly 2 to 1 ratio between bachelor's degrees in engineering and the number of graduates of engineering technology programs in any given year. Enrollments in technology programs are now climbing as the tidal wave of students hits our institutions of higher education, but technology enrollments had been rather stable for a number of years--when engineering enrollments were also stable or declining.

Finally, I gather from various comments and opinions expressed from time to time that industry is not wholly pleased with the preparations and dispositions of many of our graduates of engineering programs. For instance, of the engineering graduates who can be recruited by industry at the end of their undergraduate programs, many either have very modest or mediocre academic records or are more interested in research and development and less in the types of problems which engineering graduates of the past were more willing to tackle.

Rationale for Four-Year Engineering Technology Programs

Against the background of this current scene which I have quickly sketched, I would like to present some of the arguments and rationale which have come to my attention and which support the idea of four-year engineering technology programs.

First of all, it is said that, from the point of view of the student, such programs would provide a much-needed alternative to the choices now available to high school graduates. Assume that we are talking about graduates who have, by all general measures available, both the ability to complete a college education and the determination to do so. Assume further that these potential college students' interests

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3/ Since the presentation of this paper, a study by Jesse J. DeFore (Dean of Engineering Technologies at Lake Michigan College) reveals 73 institutions with four-year technology programs and a paper based on this study is a part of the set of three mentioned in footnote 2.

lie generally in the domain embraced by science, engineering, and technology, but that they are not particularly directed toward the modern science or engineering programs, leaning more toward the field of technology. Until the emergence of four-year technology programs, such able students were faced with pursuing programs leading to an associate degree (in the face of peer group, parental, and general society pressure for a bachelor's degree), or embarking upon engineering degree programs (with the attendant risk of becoming "also rans" in a race for which they had little enthusiasm in the first place), or pursuing a secondary interest for a college major. There must be many students facing such a "tri-lemma," and I leave to conjecture how many may be following the latter two paths.

Taking now the educator's point of view, some have said that an expansion of two-year technology programs to bachelor's degree programs would involve a degradation of the notion of a college degree. But this is disputed by other educators who point out that if these students can be shown to be college-level material by normal standards, and if the programs are sufficiently demanding to challenge these capable minds, the standards of collegiate education need not be placed in jeopardy. These same individuals also point to the precedents (some of long standing) of bachelor's programs in technology in other areas--medical technology, dental technology, etc.

From the point of view of "educational dynamics," if it is fair to say that the center of gravity of programs of formal education for entrance into the engineering profession is shifting to the post-baccalaureate level--to graduate-level professional schools of engineering--then this would seem to leave at the undergraduate level a sort of educational vacuum into which something is very likely to move. If undergraduate programs in engineering become largely preprofessional and preparatory for more advanced study, then there would seem to be a real need for an undergraduate program in technology which would be much more terminal in character.

Some argue from a manpower utilization point of view. Thus, if years ago, when the vast majority of engineering graduates terminated their formal education at the bachelor's level, it was necessary for engineering technicians to have two years of preparation, it should follow that now that many engineers are trained to the master's degree and beyond, the preparation of the professional aide must be extended too, to the bachelor's level perhaps.

From a related manpower utilization viewpoint, it has been argued that the availability of a bachelor's degree program in technology might increase the possibility of overturning the unfortunate ratio of engineers to technologists and technicians which now exists. Sound and well-publicized four-year technology programs might profitably siphon away some of the students who now enroll in engineering programs but who are never likely to practice engineering in the current and future professional senses.

And now, from the viewpoint of those who may be associated with engineering technology programs which are accredited by the Engineers' Council for Professional Development and which are of less than four-year length, in addition to all of the other arguments above, there is a matter of maintenance of identity and even of self-preservation. I gather that some educators have felt mighty uncomfortable with the emergence of the two-year technician programs stemming from the NDEA and subsequent legislation--feeling that very real differences of kind and quality were being blurred and that the traditional image and identity of engineering technology were (and are) in jeopardy. If so, those who do not feel that they can reverse the trend of events, may wish to transform their programs to engineering technology programs of four-year duration. In fact, a subcommittee of the ECPD Committee on Engineering Technology has been busy preparing criteria for passing judgment on such programs. 4/

4/ A summary of this report, popularly known as the "McCallick Report," is available from the Engineers' Council for Professional Development (345 East 47th Street; New York, New York 10017).

Similarly, from the point of view of preserving the traditional engineering technology schools, there may not be much time left to ponder and achieve this transformation because, to employ a military metaphor, they are being outflanked by the emergence of four-year technology programs growing out of the industrial arts heritage. It is certainly true that their nature and purpose are quite different from the ECPD accredited technology programs (e.g., many of them have less mathematics and science in four years than engineering technicians receive in two), but this may not be eminently clear to the potential student. I do not wish to imply that some programs are better or worse than others; the fact remains that they are different. Although the aggregate enrollment in these programs is still relatively small, there are perhaps four dozen such programs in existence already (most of which have emerged since World War II), and their potential drawing power is probably very large.

Finally, from the point of view of some schools which for decades have claimed to give engineering degrees but which have never succeeded in getting these accredited as engineering programs by ECPD, the emergence of bachelor's degree programs in engineering technology may provide a new avenue of excellence, one more in keeping with their spirit and flavor, and one which could lead to ECPD accreditation in engineering technology.

Possible Relationships Among Programs

So much for the various arguments and viewpoints in support of four-year engineering technology programs. One may ask how, in the future, these might mesh with the consequences of the other trends which are discernible today. In attempting to cope with this question, I must point out that we are beyond the relevant facts in the current scene (the first part of this paper) and beyond a review and summary of other people's arguments (the part just concluded). We are not in the realm of what is, but what could be. Furthermore, my neutral role does not permit me to predict what I think will happen, much less to try to prescribe what should happen. I shall merely present something that could happen.

At some future time, we could have at the undergraduate level at least four basic types of programs leading to bachelor's degrees--programs in science, engineering science, engineering, and engineering technology. Let me suggest the relationships which might exist among them.

By programs in science I mean the natural sciences, the disciplines concerned with the understanding of nature and natural phenomena--physics, chemistry, geology, biology, etc. Programs of this type have long served two purposes--providing the undergraduate preparation for future scientists (most of whom are trained to the doctorate) and providing a science-flavored form of liberal education which serves as a useful base for a variety of other careers and occupations (among which are some graduates who switch into engineering science or engineering). Such undergraduate science programs will surely continue to exist, with advanced science programs leading to the doctorate, and with honorable exit and crossover points at various levels (particularly at the conclusion of the undergraduate program) for students with changing or unusual career interests.

Turning to the engineering science programs, I should begin by mentioning the concept of engineering science which is implicit in what will follow. As the counterpart of natural science, which is concerned with understanding nature and natural phenomena, I regard engineering science as the body of knowledge dealing with the properties, characteristics, and behavior of man-made systems, devices, structures, and processes. One could pursue such knowledge for several reasons, and hence such programs could serve several purposes. First of all, a knowledge of the characteristics of engineering devices, systems, and structures could serve as a very sound and versatile base for careers in other areas--law, technical writing, management, etc. Indeed, a fraction of our engineering graduates have been successfully embarking upon such careers for many years. In the future, engineering science programs could become a more widely-recognized and utilized channel to such other careers--careers in which a knowledge of engineering science will be useful.

Other students could select engineering science programs as the base for an education extending to a doctor's degree in engineering science and to careers in engineering research leading to the extension and enrichment of our knowledge of man-made (i.e., engineering) devices and systems. Parenthetically, in the opinion of some, such is the character of many, or most, of our graduate programs in engineering today. Being engineering-research oriented, they could eventually be labelled advanced engineering science programs.

Considering now the bachelor's degree programs in engineering, they could come to have a flavor which engineering science programs need not have--experience in solving new and whole engineering problems, whole in the sense that they include not only the technical core but also take into account in any design such factors as cost, time scale, weight, size, safety, reliability, etc.--in short, all of the economic, legal, social, political, cultural and other constraints which may apply. In my private lexicon, the existence of one or more important non-technical constraints is what distinguishes an engineering problem from a technical problem. The engineer, in his professional role, is responsible to society for properly accounting for these non-technical dimensions of the total problem. Such programs would therefore be oriented toward the solution of the problems raised by mankind's unending desires for better communication, transportation, energy distribution, shelter, defense, nutrition, etc. They would foster the creativity, ingenuity, and innovative talent of the student, and would lead to graduate-level professional schools of engineering embodying the same flavor of "clinical engineering." A few institutions are already of this type. Many more could follow. The undergraduate programs would be designed as pre-professional, although some graduates would exit at the bachelor's level and transfer to other stems or to immediate employment.

The bachelor's degree programs in engineering technology could be largely terminal in character and designed to prepare technologists who could handle with great competence, more even that that of the engineer, the detailed solution of the technical core of an overall engineering problem--assuming that the technical problem involved no radical departures from the state of the art. With a detailed knowledge of the relevant practices, procedures, codes, etc., the technologist would render invaluable assistance in transforming from concept to reality the device or system conceived in the mind of the engineer.

If you say that these engineering technology programs sound like the engineering programs of some time ago, you may or may not be right. It would be safer, in my opinion, to say that the graduates of such engineering technology programs would be able and willing to perform for industry the very necessary tasks which in the past engineering graduates were more willing to perform. Please note that I am not admitting that these jobs are (or ever were) engineering jobs in the sense that the word "engineering" is coming to have. Furthermore, I am not saying that engineers of today and tomorrow work on "theoretical" problems while technologists are inheriting the "practical" problems, or that engineers are "theory-oriented" while technologists are "application-oriented." Such notions may have popped up because of the confusion of engineering and engineering science. To me, an engineering problem is a practical problem by definition, and it involves applications of scientific and engineering knowledge. Engineers and engineering technologists simply make different and indispensable contributions to the solution of the same problems.

In terms of these four types of programs which I have hastily outlined, one might say that a few of the accredited engineering programs of today, and a reasonably large fraction of the unaccredited engineering programs, seem to be not so much engineering programs (as I am using the term) as schizophrenic blends of engineering science and engineering technology. Many of such programs were in the past heavily flavored with engineering technology, although they were (and continue to be) called engineering. Along came the Grinter Report, catapulting the term "engineering science" into prominence, and some of these programs, with some grumbling from faculty members committed to the older flavor, began to sprout numerous so-called engineering science courses.

However, even though undergraduate engineering programs as I view them would contain components of engineering science and engineering technology, I doubt that a mixture of these two ingredients alone ever has or can yield the unique engineering flavor which I tried to describe above--the "clinical" experience of dealing with whole engineering problems--not only the technical core but all of the other relevant dimensions as well. If this characterization of some of the existing so-called engineering programs of today is at all reasonable, if they have a "neither-fish-nor-fowl" character resulting from unintegrated chunks of engineering science and engineering technology, then they might be better off to have either an engineering science program, or an engineering technology program, or both, rather than a mixture of the two with an inappropriate label of "engineering."

I should hasten to point out that the four types of programs which I have reviewed quickly--in a spectrum running through science, engineering science, engineering, and engineering technology--would, if they come to pass, have to be supported by many two-year technician programs. It seems to me that graduates at the two-year level should be more numerous than the four-year technologists, and the latter more numerous than the professional engineers in any optimum long-range solution.

Conclusion

I have tried to review the current scene, to summarize some of the arguments in support of four-year engineering technology programs, and to show how these could fit into a pattern of educational programs in the future. I have deliberately avoided almost completely such things as a detailed description of the various blends of courses in each of these types of undergraduate programs, a discussion of possible accreditation policies of the future, and other relevant points. Let me just conclude with the thought that the question is not whether or not there should be four-year technology programs--they are already here. What is more, fifty or more of these have grown up quite apart from the engineering community and its established institutions. Further, there is no longer a question about four-year engineering technology programs. They too are here. The real question is how the engineering profession will maintain the close working relationships with these high-level support personnel who play such an important a part on the engineering team.

Chapter 5

AN EVALUATION OF BACCALAUREATE PROGRAMS IN ENGINEERING TECHNOLOGY

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Introduction

During the early spring of 1966, an intensive investigation was made of baccalaureate programs in engineering technology or in an industrial technology related to the engineering field. This study was made primarily because the emergence of such programs was a contemporary development in technological education in the United States, one which had not hitherto been assessed. The investigator collected data and attempted to answer, among others, the following questions about baccalaureate programs in engineering technology:

(1) To what extent do such curricula exist?

(2) What curricular characteristics do the various existing program have?

(3) In what manner and to what extent do these programs differ from related four-year engineering programs on the one hand and two year engineering technology programs on the other?

(4) What assessment and evaluation do faculty members, graduates, employers, professional engineers, and engineering educators give these curricula?

(The complete study is titled "Baccalaureate Programs in Engineering Technology: A Study of Their Emergence and of Some Characteristics of Their Content." It is available in microfilm format from University Microfilms, Ann Arbor, Michigan, or as a document on interlibrary loan from Florida State University.)

The central focus of this paper is on the evaluation of these curricula which was made in the course of the study just mentioned. It is desirable, however, to summarize briefly some of the other findings reported therein as an introduction to the subject here.

Extent of the Programs

Seventy-three institutions in the United States were identified as offering such curricula. Altogether, these 73 institutions offered 189 different curricula or options. Thirty-three states had such curricula in 1966, California and Ohio having had the greatest numbers. The programs were found to be distributed fairly evenly geographically, with the exception of the northeast section of the country, where only one institution was identified. The majority of these programs had been founded since 1950, fourteen of them in the 1960's.

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The Nature of the Programs

It was discovered that baccalaureate engineering technology curricula could be assigned to ten categories, including aeronautical, automotive, architectural, civil, drafting, electrical and/or electronics, graphic arts, mechanical, production and industrial, and others. Curricula entitled "Production Technology," "Industrial Technology," and the like were found to be the most numerous, with the mechanical, electrical, architectural, and drafting areas next. The most popular title for the completion credential was found to be the undesignated B.S. degree.

A curriculum analysis was made in terms of the required credits in certain curricular areas. The results are shown in Table 1. The category "other" in the table.

Table 1. --- Semester hour credits required in eight curricular areas of baccalaureate engineering technology curricular.

	Semester Hours Required		
Curricular Area	Range	Median	Mean
Technical Specialty Subjects	15-53	34	34
Related Technical Study	4-41	20	20
Engineering Science	0-29[a]	0	3
Mathematics	3-27	10	9
Physical Science	3-25	13	13
Communications	4-22	9	9
Humanities-Social Studies	7-46	19	21
Other	0-46	17	18
TOTAL TECHNICAL STUDY[b]	31-83	54	57
TOTAL	124-145	130	130

[a] A strong mode in this category exists at zero semester hours. The median and mean reported are for all programs; if only those programs having some engineering science in the curriculum are considered the median and mean are 6 and 7 semester hours, respectively.

[b] This category includes Technical Specialty Subjects, Related Technical Study, and Engineering Science. Includes military science, physical education, life science, foreign language, and some unrestricted electives.

As shown in the table, the total credit requirement in baccalaureate engineering technology curricula had a range from 124 semester hours to 145 semester hours; the mean requirement was 130 semester hours. A mean of 57 semester hours was devoted to total technical study (the technical specialty subjects, related technical study, engineering science); this represented approximately 44 per cent of the mean total credits. The distribution of mean requirements in terms of percentages is shown in Table 2.

Table 2. --- Percentage distribution of required semester hour credits in baccalaureate engineering technology curricula.

Curricular Area	Percentage of Total Requirements[a]
Technical Specialty Subjects	26
Related Technical Study	15
Engineering Science	2
Mathematics	7
Physical Science	10
Communications	7
Humanities-Social Studies	16
Other	14
Total Technical Study	44

[a] Percentage entries are rounded to the nearest integer; hence, sums may not total 100 per cent.

Baccalaureate engineering technology curricula exhibited both similarities to and differences from conventional four-year engineering curricula. Some of the major differences in the course patterns of these two are shown in Table 3.

Table 3. --- Comparison of mean semester hours credit requirements in baccalaureate engineering technology curricula and four-year engineering curricula.

Curricular Area	Mean Semester Hours Credit Requirements Four-year Engineering	Engineering Technology
Technical Specialty Subjects	32	34
Related Technical Study	14	20
Engineering Science	23	3
Mathematics	17	9
Physical Science	18	13
Communications	7	9
Humanities-Social Studies	18	21
Other	10	18
Total Technical Study	69	57
TOTAL	141	130

The content of the two kinds of curricula, in terms of required semester hours credit, was commensurate in the curricular areas of technical specialty subjects, communications, and humanities-social studies, but there were noteworthy differences in other parts of the course patterns. For example, engineering technology required approximately 50 per cent more time in related technical studies than did engineering curricula. The additional requirements for engineering technology included mainly studies of a laboratory or shop nature. That certain of these studies no longer appeared in engineering curricula undoubtedly reflected the philosopy of a science-related approach to engineering education emphasized in the "Grinter Report" of 1955 and restated in the ASEE "Goals Study" now under discussion; that they did appear in engineering technology curricula perhaps reflected a greater commitment on the part of the administrators of these programs to studies involving engineering methodology and practice.

Four-year engineering programs contained a greater number of required semester hours credits in the engineering sciences, mathematics and the physical sciences than did engineering technology curricula. The mean requirement in the engineering science area for a four-year degree in engineering was 23 hours, seven times greater than the mean of three semester hours required in baccalaureate engineering technology programs. Similarly, the mean mathematics requirement in engineering curricula, 17 semester hours, was nearly double that in baccalaureate engineering technology curricula, 9 semester hours. And the mean physical science content in engineering curricula exceeded that of baccalaureate engineering technology curricula by nearly 40 per cent.

A noteworthy difference between these two kinds is to be found in the total number of semester hours required for the degree. Engineering curricula required of 141 semester hours total credits, whereas the mean total credit requirement for technology curricula was only 130 semester hours. The difference is equivalent to nearly one semester of study, based on a normal load of 16 semester hours credit.

Baccalaureate engineering technology programs had a number of curriculum characteristics in common with the more familiar associate degree programs and some important differences. These similarities and differences are summarized in Table 4.

Table 4 --- Comparison of the course patterns of baccalaureate engineering technology curricula and associate degree engineering technology.

Curricular Area	Mean Degreement Requirements[a]			
	Baccalaureate Programs		Associate Degree Programs	
	Sem. Hrs.	(%)	Sem. Hrs.	(%)
Technical Specialty Subjects	34	(26)	22	(32)
Related Technical Study	20	(15)	12	(18)
Engineering Science	3	(2)	4	(6)
Mathematics	9	(7)	8	(12)
Physical Science	13	(10)	8	(12)
Communications	9	(7)	6	(9)
Humanities-Social Studies	21	(16)	5	(7)
Other	18	(14)	4	(6)
Total Technical Study	57	(44)	38	(56)
TOTAL	130	--	68	--

[a] Percentage entries are rounded to the nearest integer; sums, therefore, may not total 100 per cent.

As shown in Table 4, the mean numbers of semester hour credits required in engineering science, mathematics, and communications were approximately the same in both baccalaureate and associate degree curricula, although these numbers of credits represented a slightly smaller percentage of the total requirements in

Baccalaureate curricula than in associate degree curricula. An appreciably greater proportion of the total requirements lay in humanities and social studies in baccalaureate curricula than in associate degree curricula; a mean of 16 per cent of the total time was allotted to this area in baccalaureate curricula, while a mean of only seven per cent was so assigned in associate degree curricula.

The baccalaureate technology programs had a mean requirement of 34 semester hours credit in the technical specialty; this represented 26 per cent of their mean total requirement. Associate degree curricula, on the other hand, required a mean of 22 semester hours credit in this curricular area, a proportion of 32 per cent. Baccalaureate curricula, although their mean total requirement was nearly twice that of associate degree programs, included a mean of only 12 semester hours additional credit in the technical specialty, a mere 55 per cent increase over the technical specialty content of associate degree curricula.

Evaluations

Perceptions of Faculty Members

Faculty members at institutions which offered baccalaureate engineering technology programs were asked to give their perceptions of the degree of acceptance accorded to these programs and to the graduates from them. A questionnaire instrument was administered; 121 usable responses (about 70 per cent of the sample) were received. The data collected suggested that: (1) both faculty members and their student recognized the programs as filling a significant need, (2) the graduates seemed satisfied with their educational experiences, and (3) employers seemed pleased with the qualifications of the graduates.

Information from Graduates

Graduates of baccalaureate engineering technology programs, in general, reported that their initial job titles fell into a category which reflected the level of education they had received: 87 per cent of the graduates who responded to a questionnaire indicated this to be the case. The mean salary which these men indicated they received was $465 per month. They reported a 14.6% annual rate of increase in salary. These data, when compared to corresponding data for four-year engineering graduates and for associate degree graduates indicate that graduates of the program were successful in finding appropriate employment at realistic salary levels.

These men made criticisms of and suggestions for changes in the curricula from which they graduated. By and large, these individuals reported they were pleased by their educational experiences. Some of the suggestions they made included the following:

> "Add business and management course"
> "Add more mathematics courses"
> "Add courses in computers and computer programming"
> "Add courses in law"
> "Add more engineering science courses"
> "Introduce a work-study plan"
> "Delete some shop courses"
> "Delete some humanities courses"

Comments by Employers

A sample of the employers of the graduates of baccalaureate engineering technology programs was surveyed on questions dealing with curricula. These employers were in substantial agreement that the curricula were adequate. Some suggestions made included the following:

"Increase credits required in engineering science"
"Increase credits required in mathematics"
"Increase credits required in physical science"
"Add requirements in business subjects"
"Add requirements in statistics"
"Increase requirements in communications"

It is perhaps noteworthy that both employers and graduates suggested addition of requirements in mathematics and business-related subjects to the curricula.

Evaluation by a Jury

A jury consisting of ten persons--engineering educators, engineering technology (associate degree level) educators, professional engineers, and industrialists reviewed and evaluated these programs. These individuals were requested to review and assess the content and objectives of baccalaureate programs in engineering technology and to comment on their perceptions of the roles the graduates of such curricula might be expected to play. The members of the jury received copies of (1) the definitions used in this study, (2) a course pattern outline for a baccalaureate engineering technology program listing the means found for the eight curricular areas as shown previously in Table 1, (3) three illustrative curriculum outlines for selected programs, (4) a list of the stated objectives of baccalaureate engineering technology programs, excerpted from the published catalogs and bulletins of selected institutions, and (5) a check-list on which they could record their reactions and comments.

One jury member made no entries on the check-list supplied but stated his overall reactions to baccalaureate engineering technology programs in these words:

> "I do not feel that a four-year program leading to a Bachelor of Science degree in technology is appropriate for the future development of engineering... I am... in total disagreement with the philosophy... My general recommendation is that the complete four-year program leading to a Bachelor of Science in engineering technology be dropped...

Only nine sets of responses, therefore, needed to be included in subsequent analyses of the jury response.

The jury members assessed the level of competence of technological workers which was implied by the existence of baccalaureate engineering technology programs. Eight indicated they believed this level of competence existed, that there was a need for individuals so educated, and that a special curriculum--differing both from traditional engineering curricula and from associate degree engineering technology curricula--was required for training such individuals. Only five jury members, however, believed the level of competence implied could be separately identified.

In evaluating the course pattern for baccalaureate engineering technology curricula, the jury members were in substantial agreement that the mean requirements in the curricular areas of technical specialty subjects and related technical studies were appropriate. A majority of jury members agreed that the mean requirements in engineering science, physical science, communications, and humanities-social studies were "about right." A majority of jury members agreed that the mathematics requirements were insufficient.

The jury members were asked to judge how realistic were certain stated objectives of baccalaureate engineering technology programs. A majority of the jury members believed the objectives as stated needed only minor modification. These men also commented that a revision of the mathematics content in the sample curricula they examined would be necessary before these curricula would meet the objectives as the jury members interpreted them.

The nine jury members who responded favorable were unanimous in stating that they believe the graduates of baccalaureate engineering technology programs could play useful roles in society. Quotations from three of the jury members follow:

> Graduates of such programs can, do and will play useful roles in society. The need is accelerating...
>
> Because engineering has changed from application to science, from the specific to the general, from the "cut and try" to mathematical prediction, there is an increasing void in the training in engineering "hardware," techniques and skills. Industry needs...the specialist in engineering hardware applications.
>
> We believe that graduates of such programs can play a useful role in industry and society and particularly so if the recommendations of the ASEE study are carried out in many institutions with regard to granting the first professional degree at the master's level. Graduates in engineering technology can play a very useful role in many areas of manufacturing, sales, engineering writing, field service, quality control, and in other general engineering support activities.

Summary

Baccalaureate engineering technology programs were compared to both four-year engineering programs and two-year engineering programs. As compared to four-year engineering programs, baccalaureate engineering technology programs tended to concentrate more on technological methodology, to be more flexible, to contain less science-related subject matter, and to require fewer total credits for the degree. As compared to associate degree engineering technology programs, baccalaureate engineering technology programs appeared appreciable less intensive, required a smaller proportion of their total credits in the technical areas, and had a larger proportion of the total requirements in the curricular area which included unrestricted electives.

A jury of engineering educators, engineering technology educators, professional engineers, and industrial representatives examined definitions, curricula, and curriculum objectives for baccalaureate engineering technology programs. The members of this jury were in substantial agreement that the level of technological worker implied by the definition existed, could be identified and distinguished from related levels, and required special curricula. The jury members were in substantial agreement that the mean semester hours credit requirements were "about right" for seven of the eight curricular areas considered herein and were "too small" for mathematics. These evaluators agreed that certain stated curriculum objectives for these programs were realistic or needed only minor modification. And these men were unanimous in perceiving as useful the role in society of the graduates of baccalaureate engineering technology programs.

Chapter 6

THE ESTABLISHMENT OF ECPD ACCREDITATION FOR BACCALAUREATE DEGREE PROGRAMS IN ENGINEERING TECHNOLOGY

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July 1967

In 1964, at the request of ECPD President W. Scott Hill, the Engineering Technology Committee established a subcommittee with Dr. Hugh McCallick, Dean, College of Technology, University of Houston, as chairman, to study the emerging four-year programs in engineering technology. This committee's report, released in June 1965, was published as part of the Engineering Technology Committee report in the 33rd ECPD Annual Report.

In the meantime, the Engineering Technology Committee received a request to accredit a four-year baccalaureate program in engineering technology and the Board of Directors authorized a revision of the Objectives and Procedures statement for the accreditation of curricula leading to first degrees in engineering technology in the United States as published in the 32nd ECPD Annual Report to state that "programs normally lead to the associate or baccalaureate Degree."

After completing their first report the McCallick committee was asked to develop guidelines for the evaluation and accreditation of four-year programs in engineering technology. This committee did a very thorough and scholarly job, and their report was completed and dated February 2, 1966.

During the December 13, 1965, ECPD Executive Committee meeting, President L. E. Grinter appointed a subcommittee with Dean M. R. Lohmann of Oklahoma State University as chairman, to "consider in depth the problems presented by the request for accreditation of four-year curricula in engineering technology." Therefore the McCallick committee report was referred through channels to the Lohmann committee for study in developing guidelines and criteria for evaluating four-year baccalaureate programs in engineering technology.

After considerable deliberation, the Lohmann committee recommended that the present criteria for the evaluation of curricula of two academic years' duration, be used to evaluate curricula of greater length. The exact statement of the committee is as follows: "ECPD accreditation is based on compliance with minimum criteria established for curricula of not less than two academic years' duration. These criteria are applied regardless of the total length of the curriculum beyond the two academic years and thus are applicable to curricula which may lead to either the associate or baccalaureate degree."

On the basis of the Lohmann committee's recommendation, the Board of Directors on October 4, 1966, authorized the Engineering Technology Committee to evaluate for accreditation four-year baccalaureate programs in engineering technology and the necessary revisions in official evaluative criteria to permit this.

The McCallick report is now a part of the literature on engineering technology education. It should no doubt be used by the Technical Institute Administrative Council of ASEE in updating the McGraw Report-"Characteristics of Excellence in Engineering Technology Education," to include information on four-year baccalaureate programs in engineering technology.

ECPD accreditation at the present time, therefore, is based on compliance with minimum criteria established for curricula of not less than two academic years' duration. These criteria are applied regardless of the total length of the curriculum beyond the two academic years and thus are applicable to curricula which may lead either to the associate or baccalaureate degree.

These curricula have in common the following purposes and characteristics:

1. The purpose is to prepare individuals for various technical positions or lines of activity encompassed within the field of engineering, but the

scope of the programs is more limited than that required to prepare a person for a career as a professional engineer.

2. Programs of instruction are essentially technological in nature, are based upon principles of science, and include sufficient college-level mathematics to provide the tools to accomplish the technical objectives of the curricula.

3. Emphasis is placedupon the use of rational processes in the principal fundamental portions of the curricula that fulfill the stated objectives and purposes.

4. Programs of instruction are usually more completely technological in content than engineering curricula, though they are concerned with the same general fields of industry and engineering. They normally lead to the appropriate associate or baccalaureate degree. Graduates of such programs are commonly designated as Engineering Technicians.

5. Training for artisanship is not included within the scope of engineering technology education.

Evaluative criteria have as their objective the assurance of a minimum foundation for the preparation of an engineering technician. This minimum foundation insures sufficient emphasis upon the technical specialty courses which are the essence of any engineering technology curriculum.

Building on this foundation, an institution may follow a variety of patterns in the remainder of the curriculum, such patterns being consistent with the objectives of the particular program and the overall aims of the institution. These patterns include in common the following guidelines:

1. ECPD accredited engineering technology curricula may extend beyond the minimum standards of duration and quality. Curricula content beyond the minimum foundation may be planned for any one of several objectives, i.e.,

greater technical emphasis, increased liberal studies, management courses, etc.

2. The ECPD requires a high degree of specialization for engineering technology programs, but with field orientation rather than job orientation. The engineering orientation of this technical specialization should be manifest from faculty qualifications and course content.

3. The Engineering Technology Committee is prepared to examine for approval any college-level curriculum that appears likely to satisfy its criteria for an engineering technology curriculum. Curricula of a vocational pattern cannot qualify, nor can curricula of so specialized a pattern or so job-oriented as to provide an inadequate base for engineering technology.

A discussion of the philosophy of, and the guidelines for, Engineering Technology education may be found in reports and publications of the American Society for Engineering Education.

4. The Engineering Technology Committee wiil not recommend for accreditation as a curriculum in engineering technology any curriculum for which the claim is made that it produces qualified engineers. Caution and discretion must be exercised by institutions in all publications and references to avoid ambiguity or confusion between engineering technology and engineering. No curriculum will be approved for accreditation or reaccreditation unless the word "technology" is used as the final noun in the title.

Programs leading to the Baccalaureate Degree in Engineering Technology now are in the process of being evaluated by the Engineering Technology Committee of ECPD. Furthermore, institutions presently conducting four-year programs have expressed a decided interest in applying for accreditation when required conditions have been satisfied to include the placement of graduates. It is indicated through requests for information and expressions of interest that this area of education in engineering technology soon will experience a considerable expansion in its list of accrediting curricula.

Appendix 1

A Selected Bibliography of Recent and Significant Publications Dealing with Technician Manpower

American Society for Engineering Education, "Characteristics of Excellence in Engineering Technology Education," 1962, ASEE, 1346 Connecticut Avenue, N.W. Washington, D. C.

American Society for Engineering Education, *Journal of Engineering Education*, Vol. 57, No. 3, Nov. 1966, (Special issue on Education of the Engineering Technician) ASEE, 1346 Connecticut Avenue, N. W., Washington, D. C.

American Society for Engineering Education, A set of three papers on this subject presented at the October 1966 meeting of the Engineers' Council for Professional Development may be requested from ASEE, 1346 Connecticut Avenue, N.W., Washington, D. C. (Includes paper reprinted as Chapter 5 of this report.)

Engineers' Council for Professional Development, "Curricula Leading to Degrees in Engineering Technology in the United States Accredited by the ECPD," 1966, by the Council, 345 East 47th Street, New York, New York. (Price 25 cents.)

Engineering Manpower Commission of Engineers Joint Council, "Salaries of Engineering Technicians 1966," July 1966, by the Council, 345 East 47th Street, New York, New York. (Price $5.00)

Engineering Manpower Commission of Engineers Joint Council, "Demand for Engineers and Technicians--1966," Nov. 1966, by the Council, 345 East 47th Street, New York, New York. (Price $4.00)

New York State Department of Labor, Division of Research and Statistics, "Technical Manpower in New York State," Special Bulletin 239, Dec. 1964.

Technician Education Yearbook, Prakken Publications, Inc., Ann Arbor, Michigan.

U. S. Department of Health, Education, and Welfare, "Guide to Organized Occupational Curriculums in Higher Education," OE-54 012-62 Circular No. 771, 1965, U. S. Government Printing Office, Washington, D. C. 20402 (Price 60 cents.)

U. S. Department of Health, Education, and Welfare, "Organized Occupational Curriculums in Higher Education - Enrollments and Graduates, 1958," OE-54012 Circular No. 632, 1961, U. S. Government Printing Office, Washington, D. C. 20402 (Price $1.50)

U. S. Department of Health, Education, and Welfare Technical Education Program Series, Various Titles and Dates, U. S. Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

U. S. Department of Health, Education, and Welfare, "Job Descriptions and Suggested Techniques for Determining Courses of Study in Vocational Education Programs," various titles and dates in series, U. S. Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

U. S. Department of Labor, "Technician Manpower: Requirement, Resources, and Training Needs," Bulletin No. 1512, June 1966, U. S. Government Printing Office, Washington, D. C. 20402 (Price 60 cents.)

U. S. Department of Labor, "Technology and Manpower in Design and Drafting 1965-75," Manpower Research Bulletin No. 12, October 1966, U. S. Department of Labor, Manpower Administration, Washington, D. C.

U. S. Department of Labor, "National Survey of Professional, Administrative, Technical, and Clerical Pay," Bulletin No. 1535, October 1966, U. S. Government Printing Office, Washington, D. C. 20402 (Price 50 cents)

"The Engineer and the Technician" (5 articles by various authors.) Chemical Engineering Progress, Vol. 63, No. 5, May 1967, page 26 - 43.

Appendix 2

The institutions listed below responded to either the 1965-66 or 1966-67 EMC technician enrollment and graduate survey as having programs in the areas listed. Institutions are listed by state. Those which have one or more ECPD - accredited curriculum as of 1966 are preceded by an asterisk.

A full description of the ECPD accreditation program and the specific curriculums covered is published under the title "Curricula Leading to Degrees in Engineering Technology in the United States." This is available at 25 cents per copy from Engineers' Council for Professional Development, 345 East 47th Street, New York, New York 10017.

State	Name of School & City	Engrg. Tech.	Physical Sci. or Ind. Tech.	Bach. of Engrg. Tech.	Bach. of Ind. Tech.	Pre Engrg.
Alabama	William Lowndes Yancey - Bay Minette					X
	Jefferson State Jr. - Birmingham	X	X			X
	Wenonah Jr. - Birmingham					X
	John C. Calhoun - Decatur	X				X
	George C. Wallace - Dothan					X
	Enterprise Jr. - Enterprise					X
	Gadsden State Jr. - Gadsden	X				X
	Walker College - Jasper					X
	Patterson State Voc. - Montgomery		X			
	Ala. A & M College - Normal	X			X	
	Northeast State Jr. - Rainsville	X				X
	Shelton State Tech. - Tuscaloosa	X	X			
Alaska	Anchorage Comm. - Anchorage		X			X
Arizona	Cochise College - Douglas	X				
	Northern Ariz. Univ. - Flagstaff	X			X	X
	Glendale College - Glendale	X	X			X
	Mesa Comm. College - Mesa	X	X			X
	Maricopa County Jr. - Phoenix	X				X
	Phoenix Coll. - Phoenix	X	X			X
	Eastern Ariz. Coll. - Thatcher	X	X			
Arkansas	Arkansas State Tea. - Conway					X
	Westark Jr. Coll. Tech. - Ft. Smith	X	X			
	Southern State - Magnolia	X	X			X
	Crowley's Ridge - Paragould					X
Calif.	Chaffey College - Alta Loma	X	X			
	Cabrillo Coll. - Aptos	X	X	X		
	Bakersfield Coll. - Bakersfield	X	X			
	West Valley Coll. - Campbell	X				X
	Chico State Coll. - Chico			X		
	Southwestern Coll. - Chula Vista	X	X			X
	Coalinga Coll. - Coalinga	X	X			
	Orange Coast Coll. - Costa Mesa	X	X		X	X
	Grossmont Coll. - El Cajon	X				X
	Coll. of the Redwoods - Eureka		X			
	Fresno State - Fresno		X		X	
	Fullerton Jr. - Fullerton	X	X			X
	Gavilan Coll. - Gilroy	X				X
	Glendale Coll. - Glendale	X	X			
	Chabot College - Hayward	X	X			X

State	Name of School & City	Engrg. Tech.	Physical Sci. or Ind. Tech.	Bach. of Engrg. Tech.	Bach. of Ind. Tech.	Pre Engrg.
Calif.	Golden West Coll. - Huntington Beach	X				
	Imperial Valley - Imperial	X				X
	*Northrop Insti. of Tech. - Inglewood	X				
	Western States Coll. of Engrg. - Inglewood	X				
	College of Marin - Kentfield	X	X			X
	Long Beach City Coll. - Long Beach	X	X			X
	Foothill College - Los Altos Hills	X				X
	East Los Angeles Coll. - Los Angeles	X				
	Los Angeles City - Los Angeles	X				X
	Los Angeles Trade Tech. - Los Angeles		X			
	Menlo College - Menlo					X
	Yuba College - Marysville	X	X			X
	Merced College - Merced	X				
	Monterey High School - Monterey		X			
	Monterey Peninsula Coll. - Monterey	X	X			
	Monterey Public Schools - Monterey	X	X			X
	Napa Jr. Coll. - Napa	X				X
	Cerritos Coll. - Norwalk	X				
	Laney Coll. - Oakland	X	X			
	Merritt College - Oakland	X				X
	Coll. of the Desert - Palm Desert		X			X
	Pasadena City Coll. - Pasadena	X	X		X	X
	Diablo Valley Coll. - Pleasant Hill	X	X			X
	Porterville Coll. - Porterville	X				
	Shasta Coll. - Redding					X
	Reedley Coll. - Reedley					X
	Sierra Coll. - Rocklin	X	X			X
	Amer. River Jr. - Sacramento	X	X			X
	Hartnell Coll. - Salinas	X	X			X
	San Bernardino Valley - San Bernardino	X	X			X
	San Bernardino Voc. - San Bernardino		X			
	San Diego City Coll. - San Diego		X			X
	San Diego Jr. Coll. - San Diego	X	X			
	San Diego Mesa Coll. - San Diego	X				
	*City Coll. of San Fran. - San Francisco	X				X
	Heald Engrg. Coll. - San Francisco		X			
	*Cogswell Polytech Coll. - San Francisco	X				
	San Jose City Coll. - San Jose	X	X		X	X
	Cuesta College - San Luis Obispo	X	X			X
	Palomar Jr. College - San Marcos	X	X			X
	College of San Mateo - San Mateo	X				
	Contra Costa Coll. - San Pablo	X	X			X
	Santa Ana Coll. - Santa Ana	X	X			X
	Santa Barbara City Coll. - Santa Barbara		X			
	Allan Hancock Coll. - Santa Maria	X	X			
	Santa Monica City Coll. - Santa Monica	X	X			X

State	Name of School & City	Engrg. Tech.	Physical Sci. or Ind. Tech.	Bach. of Engrg. Tech.	Bach. of Ind. Tech.	Pre Engrg.
Calif.	Humphreys Coll. - Stockton	X				
	Los Angeles Valley Coll. - Van Nuys	X	X			X
	Ventura College - Ventura	X	X			X
	Victor Valley Coll. - Victorville	X	X			X
	College of Siskiyous - Weed	X	X			X
	Rio Hondo Jr. Coll. - Whittier					X
	Los Angeles Harbor Coll. - Wilmington	X	X			
	Los Angeles Pierce Coll. - Woodland Hills	X	X			X
Colorado	Emily Griffith Oppor. Sch. - Denver	X	X			
	Fort Lewis Coll. - Durango					X
	Mesa College - Grand Junction	X				X
	Otero Jr. Coll. - La Junta	X				
	Southern Colo. State Coll. - Pueblo	X	X		X	X
	Rangely College - Rangely	X				
	Northeastern Jr. Coll. - Sterling	X	X			X
Conn.	Jr. College of Conn. - Bridgeport	X				
	*Hartford State Tech. - Hartford	X				
	Ward Tech. Insti. - Hartford	X	X			
	Manchester Comm. Coll. - Manchester		X			
	*Norwalk State Tech. Insti. - Norwalk	X				
	Thames Valley State Tech. Insti. - Norwich	X				
	Waterbury State Tech. - Waterbury	X				
Delaware	Wesley College - Dover					X
	Sussex County Voc. Tech. - Georgetown		X			
D. C.	*Capitol Insti. of Tech. - Washington	X			X	
Florida	Polk Jr. Coll. - Bartow	X				X
	Manatee Jr. Coll. - Bradenton	X	X			X
	Technical Education Center - Clearwater		X			
	Brevard Jr. College - Cocoa	X	X			X
	Daytona Beach Jr. Coll. - Daytona Beach	X	X			X
	*Embry-Riddle Aeron. Insti. - Daytona Bea.	X	X	X		
	Jr. Coll. of Broward County - Ft. Laud.	X	X			
	Edison Jr. Coll. - Fort Myers	X				X
	Indian River Jr. Coll. - Ft. Pierce	X				X
	Massey Tech. Insti. - Jacksonville	X				
	Florida Keys Jr. Coll. - Key West	X	X			X
	Lake City Jr. Coll. - Lake City	X				X
	Lake-Sumter Jr. Coll. - Leesburg	X				X
	Lyman High School - Longwood		X			
	North Flo. Jr. Coll. - Madison	X				
	Chipola Jr. Coll. - Marianna	X				X
	Miami-Dade Jr. Coll. - Miami	X	X			X
	Central Flo. Jr. Coll. - Ocala	X	X			X
	Hampton Jr. Coll. - Ocala		X			
	St. Johns River Jr. Coll. - Palatka	X				X
	Gulf Coast Jr. Coll. - Panama City	X	X			X

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Florida	Pensacola Jr. Coll. - Pensacola	X	X			X
	*St. Petersburg Jr. Coll. - St. Peters.	X				X
	Seminole High School - Sanford		X			
	Flo. A & M Univ. - Tallahassee					X
	Florida Coll. - Temple					X
Georgia	Monroe Area Voc. Tech. Sch. - Albany		X			
	South Geo. Tech. & Voc. Sch. - Americus	X	X			
	DeKalb Area Tech. Sch. - Clarkston	X	X			
	DeKalb College - Clarkston					X
	North Geo. Tech. & Voc. - Clarkesville	X	X			
	Middle Georgia Coll. - Cochran					X
	Columbus Area Voc. Tech. - Columbus	X				
	Griffin Area Voc. Tech. - Griffin	X				
	*Southern Tech. Insti. - Marietta	X				
	Coosa Valley Voc. Tech. - Rome	X	X			
	Thomas Area Voc. Tech. - Thomasville	X				
	Abraham Baldwin Agri. Coll. - Tifton	X				X
	Valdosta Area Voc. Tech. - Valdosta	X	X			
	Waycross Area Voc. Tech. - Waycross		X			
Hawaii	Univ. of Hawaii - Honolulu	X				
Idaho	Boise College - Boise	X	X			X
	North Idaho Jr. Coll. - Coeur D'Alene	X	X			X
	Idaho State Univ. - Pocatello	X				
	College of Southern Idaho - Twin Falls	X	X			
Illinois	Canton Comm. Coll. - Canton	X	X			X
	Southern Ill. Univ. - Carbondale	X	X	X	X	
	Chicago City Jr. Coll. - Chicago	X	X			X
	Chicago City Coll. - Chicago	X	X			X
	Chicago City Jr. Coll. - Chicago					X
	Chi. City Coll. So. East Branch - Chicago	X	X			X
	Chicago City Coll. Wilson Branch - Chic.	X	X			X
	Chicago City Coll. Wright Branch - Chic.	X	X			X
	Chicago Tech. Coll. - Chicago	X	X			
	*Devry Insti. of Tech. - Chicago	X	X			
	Industrial Engrg. Coll. - Chicago	X			X	
	Bloom Comm. Coll. - Chicago Hts.	X				X
	Danville Jr. Coll. - Canville	X	X			
	Decatur Public Schools - Decatur	X				
	Sauk Valley Coll. - Dixon	X	X			
	United Township H. S. - East Moline	X				
	Freeport Comm. Coll. - Freeport	X	X			X
	Thornton Jr. Coll. - Harvey	X				X
	Illinois Valley Comm. Coll. - La Salle	X				
	La Salle-Peru-Oglesby Jr. - La Salle	X				X
	Black Hawk Coll. - Moline	X	X			X

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Illinois	Wabash Valley Coll. - Mt. Carmel		X			X
	Triton Coll. - Northlake	X	X			X
	Bradley Univ. - Peoria		X		X	
	Rockford College - Rockford	X				X
	Rock Valley College - Rockford	X	X			X
	Univ. of Illinois - Urbana		X			
	Univ. of Illinois - Urbana	X				
	Township H. S. - Waukegan	X	X			
	East Alton-Wood River Area Tech. -Wood Riv.		X			
Indiana	Tri-State Coll. - Angola		X			
	Purdue Univ. Sch. of Tech. - Lafayette	X	X	X	X	
	Valparaiso Tech. Insti. - Valparaiso	X				
	Vincennes Univ. - Vincennes		X			X
Iowa	*Iowa State Univ. - Ames	X		X		
	Eastern Iowa Comm. Coll. - Bettendorf	X	X			
	Southeastern Iowa Coll. - Burlington	X	X			
	Burlington Comm. Coll. - Burlington	X	X			
	Area Voc. Tech. Sch. - Cedar Rapids	X	X			
	Centerville Comm. Coll. - Centerville		X			X
	Clarinda Comm. Coll. - Clarinda	X	X			
	Clinton Jr. Coll. - Clinton	X				
	Davenport Area Tech. - Davenport	X				
	Waldorf Coll. - Forest City		X			X
	Keokuk Comm. Coll. - Keokuk					X
	Graceland College - Lamoni					X
	Marshalltown Comm. Coll. - Marshalltown	X				X
	Mason City Jr. Coll. - Mason City	X				X
	North Iowa Area Comm. Coll. - Mason City	X				
	Iowa Tech. Ed. Center - Ottumwa	X				
	Community School - Sioux City	X				
	Hawkeye Insti. of Tech. - Waterloo	X				
	Waterloo Comm. Sch. - Waterloo	X				
Kansas	Cowley County Comm. Jr. - Arkansas City		X			X
	Coffeyville College - Coffeyville	X	X	X	X	X
	S.E. Kansas Area Voc. Tech. - Coffeyville		X			
	Dodge City Comm. Jr. Coll. - Dodge City	X				X
	Butler County Comm. Jr. Coll. - El Dorado	X	X			X
	Kansas State Tea. Coll. - Emporia					X
	Fort Hays Kan. State Coll. - Fort Hays					X
	Highland Comm. Jr. Coll. - Highland	X	X			X
	Hutchinson Comm. Jr. Coll. - Hutchinson		X		X	
	Independence Comm. Jr. - Independence		X			X
	Kan. City Comm. Jr. - Kansas City	X	X			X
	Kansas State College - Pittsburg		X		X	X
	Pratt Comm. Jr. - Pratt					X

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Kentucky	Western Area Voc. - Bowling Green		X			
	Northern Kent. State Voc. - Covington	X				
	Southeast Comm. Coll. - Cumberland	X	X			X
	Henderson Comm. Coll. - Henderson					X
	Lafayette Area Voc. - Lexington		X			
	Madisonville Area Voc. - Madisonville	X				
	Paducah Jr. College - Paducah	X	X			X
	Prestonsburg Comm. Coll. - Prestonsburg	X	X			X
	Somerset Area Voc. - Somerset	X	X			
Louisiana	Southern Univ. A & M Coll. - Baton Rouge				X	
	Sowela Tech. Insti. - Lake Charles	X	X			
	Delgado College - New Orleans	X	X			
	T. H. Harris Voc. Tech. - Opelousas	X	X			
Maine	Southern Maine Voc. Tech. - S. Portland		X			
Maryland	Baltimore Jr. Coll. - Baltimore	X				X
	Catonsville Comm. Coll. - Baltimore		X			X
	Harford Jr. College - Bel Air	X	X			X
	Allegany Comm. Coll. - Cumberland	X				X
	Essex Comm. Coll. - Essex					X
	Hagerstown Jr. Coll. - Hagerstown	X				X
	Charles County Comm. Coll. - La Plata		X			X
	Montgomery Jr. Coll. - Rockville	X	X			
	Prince George's Comm. Coll. - Suitland					X
	Montgomery Jr. Coll. - Takoma Park	X				X
Mass.	Area Voc. School - Arlington	X	X			
	North Shore Comm. Coll. - Beverly	X	X			
	*Franklin Insti. of Boston - Boston	X	X			
	Boston University - Boston	X				
	Northeastern University - Boston	X	X		X	X
	Northeast Insti. of Ind. Tech. - Boston		X			
	*Wentworth Insti. - Boston	X				
	Dean Jr. College - Franklin					X
	Mt. Wachusett Comm. Coll. - Gardner	X	X			X
	Northern Essex Comm. - Haverhill	X				
	Holyoke Comm. Coll. - Holyoke	X				X
	Lowell Tech. Insti. - Lowell	X				
	Newton Jr. College - Newton	X				
	Merrimack College - N. Andover	X				
	S.E. Mass. Tech. Insti. - N. Dartmouth	X				
	Berkshire Comm. Coll. - Pittsfield	X				X
	Quinsigamond Comm. Coll. - Worcester	X		X		
	Worcester Jr. Coll. - Worcester	X				
Michigan	Washtenaw Comm. Coll. - Ann Arbor	X	X			
	Kellogg Comm. Coll. - Battle Creek	X				X
	Lake Mich. Coll. - Benton Harbor	X	X			X
	Oakland Comm. Coll. - Bloomfield Hills	X	X			X

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Michigan	Henry Ford Comm. Coll. - Dearborn		X			X
	Detroit Engrg. Insti. - Detroit	X				
	RETS Elec. Sch. - Detroit	X	X			
	Bay De Noc Comm. Coll. - Escanaba		X			X
	Flint Comm. Jr. Coll. - Flint	X	X			X
	Grand Rapids Jr. Coll. - Grand Rapids	X	X	X	X	X
	Highland Park Coll. - Highland Park		X			X
	Michigan Tech. Univ. - Houghton	X	X			
	Gogebic Comm. Coll. - Ironwood		X			X
	Western Mich. Univ. - Kalamazoo	X	X	X	X	X
	Lansing Comm. Coll. - Lansing	X	X			
	Schoolcraft Coll. - Livonia	X				X
	Muskegon County Comm. Coll. - Muskegon	X	X			
	No. Central Mich. Coll. - Petoskey					X
	Port Huron Jr. Coll. - Port Huron	X	X			
	Lake Super. State Coll. - Sault Ste. Marie	X				
	Mich. Tech. Univ. - Sault Ste Marie	X				X
	Lawrence Insti. of Tech. - Southfield	X	X			
	No. W. Mich. Coll. - Traverse	X	X			X
	Delta Coll. - University Center	X	X			X
	Macomb County Comm. Coll. - Warren		X			
Minnesota	Austin Jr. Coll. - Austin	X				
	Anoka-Ramsey State Jr. - Circle Pines					X
Miss.	Perkinston Jr. Coll. - Perkinston	X	X			
	Pearl River Jr. Coll. - Poplarville	X	X			X
	Hinds Jr. Coll. - Raymond		X			X
	N.W. Miss. Jr. Coll. - Senatobia	X	X			X
Missouri	The Jr. Coll. Dist. of St. Louis - Clayton	X	X			X
	Florissant Valley Comm. Coll. - Ferguson	X	X			X
	Mineral Area Coll. - Flat River					X
	Jefferson College - Hillsboro	X				X
	Franklin Tech. School - Joplin	X	X			
	Miss. Southern Coll. - Joplin	X	X			X
	*Central Tech. Insti. - Kansas City	X	X			
	Metropolitan Jr. Coll. - Kansas City	X	X			X
	Meramec Comm. Coll. - Kirkwood	X	X			X
	Wentworth Mil. Academy & Jr. Coll. - Lex.					X
	Linn Tech. Jr. Coll. - Linn	X	X			
	Crowder College - Neosha	X				X
	Mo. Western Jr. Coll. - St. Joseph					X
	Florissant Valley Comm. Coll. - St. Louis	X	X			
	Forest Park Comm. Coll. - St. Louis	X				X
	School of Technology - Springfield	X				
	Central Missouri State Coll. - Warrensburg		X			
Montana	Northern Montana Coll. - Havre	X	X			X
	Custer County Jr. Coll. - Miles City		X			X

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Montana	Miles Comm. College - Miles City	X				X
Nebraska	Nebraska Voc. Tech. Sch. - Milford		X			
	Norfolk Jr. College - Norfolk	X	X			X
	University of Omaha - Omaha	X				
	Scotts Bluff College - Scottsbluff					X
Nevada	Univ. of Nevada - Reno	X				
	Washoe County School - Reno		X			
New Hampshire	New Hampshire Tech. Insti. - Concord	X				
	N. H. Voc. Insti. - Manchester		X			
New Jersey	Physics-Math. Union Jr. Coll. - Cranford					X
	Essex County Voc. Sch. - East Orange		X			
	Middlesex County Coll. - Edison	X	X			
	Cape May County Voc. Tech. - Cape May	X				
	Union County Tech. Insti. - Mountainside	X	X			
	Newark Coll. of Engrg. - Newark	X	X			
	Salem County Tech. Insti. - Penns Grove	X	X			
	Somerset County Voc. Tech. - Raritan	X				
	Fairleigh Dickinson Univ. - Teaneck	X	X			
	Warren County Voc. Sch. & Tech. - Wash.	X				
	Monmouth College - West Long Branch	X				
New Mexico	Alamogordo Comm. Coll. - Alamogordo	X				
	N. M. State Univ. - Carlsbad	X				X
	New Mexico State Univ. - Las Cruces	X				
	N. M. Highlands Univ. - Las Vegas	X	X			
	*Eastern N. M. Univ. - Portales	X			X	X
	N. M. Mining Insti. - Roswell					X
New York	*Agric. & Tech. Insti. - Alfred	X	X			X
	Auburn Comm. Coll. - Auburn	X				
	*Queensborough Comm. Coll. - Bayside	X				X
	*Broome Tech. Comm. Coll. - Binghamton	X				X
	*Bronx Comm. Coll. - Bronx	X				X
	New York City Comm. Coll. - Brooklyn	X	X			
	*Erie County Tech. Insti. - Buffalo	X				
	State Univ. of N. Y. - Buffalo	X	X			
	*State Univ. of N. Y. & Tech. - Canton	X	X			
	State Univ. of N. Y. & Tech. - Cobleskill	X	X			
	Corning Comm. College - Corning	X	X			X
	State Univ. of N. Y. & Tech. - Delhi	X				
	*State Univ. of N. Y. Agri. & Tech. - Farm.	X				X
	*Academy of Aeronautics - Flushing	X				
	Nassau Comm. Coll. - Garden City					X
	Adirondack Comm. Coll. - Hudson Falls	X				X
	Jamestown Comm. Coll. - Jamestown	X	X			X
	Fulton-Montgomery Comm. - Johnstown	X				X
	Ulster County Comm. Coll. - Kingston	X				X
	Orange County Comm. Coll. - Middletown	X				X

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New York	State Univ. of N. Y. Agr.-Tech. - Morrisv.	X				X
	Fashion Insti. of Tech. - New York	X				
	*RCA Insti. Inc. - New York	X	X			
	Vorhees Tech. Insti. - New York	X				
	Niagara County Comm. Coll. - Niagara Falls	X	X			X
	Paul Smith's Coll. - Paul Smith		X			
	Dutchess Comm. Coll. - Poughkeepsie		X			X
	Monroe Comm. Coll. - Rochester	X	X			X
	Rochester Insti. of Tech. - Rochester	X				
	Suffolk County Comm. Coll. - Selden	X	X			X
	Staten Island Comm. Coll. - Staten Island	X	X			X
	Rockland Comm. Coll. - Suffern	X				X
	Onondaga Comm. Coll. - Syracuse	X				X
	Syracuse Univ. - Syracuse	X				X
	Hudson Valley Comm. Coll. - Troy	X	X			X
	*Mohawk Valley Comm. Coll. - Utica	X				X
	Westchester Comm. Coll. - Valhalla	X				X
	Jefferson Community Coll. - Watertown					X
North Carolina	Asheville-Buncombe Tech. - Asheville	X	X			
	Brevard College - Brevard					X
	Tech. Insit. of Alamance - Burlington	X	X			
	Central Piedmont Comm. Coll. - Charlotte	X	X			X
	Durham Tech. Insti. - Durham	X	X			
	Coll. of the Albemarle - Eliz. City	X	X			
	Industrial Educ. Ct. - Fayetteville	X	X			
	*Gaston College - Gastonia	X	X			
	Wayne Tech. Insti. - Goldsboro	X	X			
	Pitt Tech. Insti. - Greenville	X	X			
	Catawba Valley Tech. - Hickory	X				
	Lenoir County Comm. Coll. - Kinston	X	X			
	Davidson County Comm. Coll. - Lexington	X	X			
	Chowan College - Murfreesboro	X	X			X
	Central Carolina Tech. - Sanford	X	X			
	Sandhills Comm. Coll. - So. Pines	X	X			X
	S.E. Comm. Coll. - Whiteville		X			
	Cape Fear Tech. - Wilmington	X	X			
	Wilson County Tech. - Wilson	X	X			
	Wingate College - Wingate					X
	Forsyth Tech. Insti. - Winston Salem	X	X			
North Dakota	Bismarck Jr. Coll. - Bismarck	X				
	N. D. Sch. of Forestry - Bottineau	X				X
	Lake Region Jr. Coll. - Devils Lake	X				
	N. D. State Sch. of Sci. - Wahpeton	X	X			X
Ohio	American Tech. Insti. - Akron	X				
	Univ. of Akron - Akron	X	X			
	Ashtabula Tech. Sch. - Ashtabula	X				

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Ohio	Ohio University - Athens		X		X	
	Canton Area Tech. Sch. - Canton	X				
	*Ohio Coll. of Appl. Sci. - Cincinnati	X	X			
	Cleveland Tech. Sch. - Cleveland	X				
	Cuyahoga Comm. Coll. - Cleveland	X				X
	Griswold Insti. Elec. Div. - Cleveland	X				X
	Columbus Tech. Insti. - Columbus	X	X			
	Franklin University - Columbus	X				
	*Ohio Tech. College - Columbus	X				
	*Sinclair Comm. Coll. - Dayton	X				
	*University of Dayton - Dayton	X		X		
	Lorain County Comm. Coll. - Elyria	X				X
	Hamilton Tech. Sch. - Hamilton	X				
	Mansfield Sch. of Tech. - Mansfield	X				
	Miami Univ.-Sci. - Oxford	X		X	X	
	Clark County Tech. Insti. - Springfield	X				
	Chandler Tech. Sch. - Willoughby	X				
Oklahoma	Oklahoma Coll. of Liberal Arts - Chickasha		X		X	
	N.E. Oklahoma A & M Coll. - Miami	X	X			X
	Okla. State Univ. Tech. - Okla. City	X				
	Sayre Jr. College - Sayre	X				X
	*Okla. St. Univ. of Agri. - Stillwater	X				
	Murray St. Agric. Coll. - Tishomingo	X				X
	Northern Okla. Coll. - Tonkawa					X
	Spartan Sch. of Aeronau. - Tulsa	X	X			
	Tulsa Tech. College - Tulsa	X	X			
	Connors St. Agri. Coll. - Warner	X				X
Oregon	Clastop Comm. Coll. - Astoria	X				
	Central Oregon Coll. - Bend	X	X			X
	S.W. Oregon Comm. Coll. - Coos Bay	X	X			
	Lane Comm. Coll. - Eugene	X	X			
	*Oregon Tech. Insit. - Klamath Falls	X	X			
	Treasure Valley Comm. Coll. - Ontario		X			X
	Oregon Polytechnic - Portland	X	X			
	Portland Comm. Coll. - Portland	X	X			
	Salem Tech. Voc. Comm. Coll. - Salem	X	X			
Penn.	Penn. State Univ. - Abington	X				
	Allentown School Dist. - Allentown		X			
	*Penn. State Univ. - Allentown	X				
	*Penn. State Univ. - Altoona	X				X
	Tech. Insti. of Alliance - Cambridge Spr.					X
	*Penn. State Univ. - Dubois	X				
	*Penn. State Univ. - Erie	X				
	Harrisburg Area Comm. - Harrisburg	X	X			X
	*Penn. State Univ. - Hazleton	X	X			
	Keystone Jr. Coll. - LaPlume					X

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Penn.	Lincoln Univ. - Lincoln University					X
	*Penn. State Univ. - McKeesport	X	X			X
	Penn. State Univ. - Middletown	X				
	Penn. State Univ. - Monaca	X	X			X
	Penn. State Univ. - Mont Alto	X				X
	Bucks County Comm. Coll. - Newtown	X	X			
	Temple University - Philadelphia	X				
	*Spring Garden Insti. - Philadelphia	X	X			
	Connelley Voc. Tech. H.S. - Pittsburgh		X			
	Penn. Tech. Insti. - Pittsburgh	X				
	Pittsburgh Tech. Insti. - Pittsburgh		X			
	Point Park College - Pittsburgh	X				
	Penn. State Univ. - Pottsville	X				
	*Penn. State Univ. - Scranton	X				
	Penn. State Univ. - Sharon	X				X
	Westinghouse Tech. Insti. - Turtle Creek	X				
	N.E. Christian Jr. Coll. - Villanova					X
	Steel Valley Area Tech. - W. Mifflin	X	X			
	*Penn. State Univ. - Wilkes-Barre	X	X			
	Williamsport Area Comm. Coll. - Wmsport	X	X			X
	Penn. State Univ. - Wyomissing	X	X			X
	*Penn. State Univ. - York	X				
	York Jr. Coll. - York					X
Puerto Rico	Univ. of Puerto Rico - Mayaguez	X				
Rhode Island	Insti. of Rhode Island - Providence		X			
	Rhode Island Jr. Coll. - Providence	X	X			X
	Roger Williams Jr. Coll. - Providence	X				
South Carolina	Richland Tech. Educ. Center - Columbia	X	X			
	Florence-Darlington Tech. - Florence	X	X			
	Spartanburg County Tech. - Spartanburg	X	X			
South Dakota	S. D. State University - Brookings	X	X			
	Southern State Coll. - Springfield	X	X			
Tennessee	Chattanooga State Tech. Insti. - Chattan.	X	X			
	Southern Missionary Coll. - Collegedale					X
	Tenn. Tech. Univ. - Cookeville				X	
	Greeneville Tech. School - Greeneville	X	X			
	E. Tenn. State Univ. - Johnson City				X	X
	Fulton Tech. Sch. - Knoxville	X	X			
	Hiwassee College - Madisonville					X
	Memphis State Univ. - Memphis				X	
	Morristown State Area Voc. - Morristown		X			
	Middle Tenn. State Coll. - Murfreesboro		X			X
	Hume-Rogg Tech. H.S. - Nashville		X			
	Martin College - Pulaski					X
Texas	Amarillo College - Amarillo	X	X	X	X	X
	*Arlington State College - Arlington	X				

State	Name of School & City	Engrg. Tech.	Physical Sci. or Ind. Tech.	Bach. of Engrg. Tech.	Bach. of Ind. Tech.	Pre Engrg.
Texas	Henderson County Jr. Coll. - Athens	X				X
	Lee College - Baytown	X	X			
	Howard County Jr. Coll. - Big Spring					X
	East Texas State Univ. - Commerce					X
	Cisco Jr. College - Cisco					X
	Christopher College - Corpus Christi					X
	Del Mar College - Corpus Christi	X	X			
	Navarro Jr. Coll. - Corsicana	X	X			
	Grayson County Coll. - Denison		X			X
	Cooke County Jr. Coll. - Gainesville	X	X			
	Hill Jr. College - Hillsboro	X	X			X
	S. Texas Jr. College - Houston					X
	*Univ. of Houston - Houston	X		X		
	Le Tourneau Coll. - Longview	X		X		
	Odessa College - Odessa	X	X			X
	San Jacinto Coll. - Pasadena	X	X			X
	San Antonio Coll. - San Antonio		X			X
	Temple Jr. Coll. - Temple	X	X			X
	Texarkana College - Texarkana	X				X
	Tyler Jr. College - Tyler	X				
	Wharton County Jr. Coll. - Wharton		X			X
Utah	Waldorf College - Forest City		X			
	Utah State Univ. - Logan		X		X	
	Engrg. Tech. Wever St. Coll. - Ogden	X	X	X	X	
	College of Eastern Utah - Price					X
	Brigham Young Univ. - Provo	X	X		X	
	Utah Trade Tech. Insti. - Provo		X			
	Dixie College - St. George	X	X			
	Salt Lake Trade Tech. - Salt Lake City	X	X			
	Utah Tech. College - Salt Lake City	X	X			
	University of Utah - Salt Lake City	X				
Vermont	*Vermont Tech. Coll. - Randolph Center	X				
Virginia	N. Va. Tech. Coll. - Bailey's Crossrds	X	X			X
	Bluefield College - Bluefield					X
	Clifton Forge-Covington Div. - Clifton For.					X
	Danville Tech. Insti. - Danville	X	X			
	George Mason Coll. - Fairfax					X
	Hampton Insti. - Hampton	X		X		
	Newport News Shipbdlg. - Newport News		X			
	Old Dominion Coll. - Norfolk	X	X			
	Richmond Prof. Insti. - Richmond	X				
	Virginia Western Comm. - Roanoke	X				
	Eastern Shore- Univ. of Va. - Wallops Is.	X				X
	University of Va. - Wise					X
	Va. Polytech Insti. - Wytheville					X
Washington	Grays Harbor Coll. - Aberdeen		X			
	Green River Comm. Coll. - Auburn	X	X			X
	Bellingham Tech. Sch. - Bellingham	X				

State	Name of School & City	Engrg. Tech.	Physical Sci. or Ind. Tech.	Bach. of Engrg. Tech.	Bach. of Ind. Tech.	Pre Engrg.
Washington	Olympic College - Bremerton	X	X			X
	Centralia College - Centralia	X	X			X
	Everett Jr. Coll. - Everett	X	X			X
	Lower Columbia Coll. - Longview	X				
	Highline College - Midway	X				X
	Big Bend Comm. Coll. - Moses Lake	X	X			X
	Skagit Valley Coll. - Mount Vernon	X				
	Olympia Voc. Tech. Insti. - Olympia	X	X			
	Columbia Basin Coll. - Pasco	X	X			
	Peninsula Coll. - Port Angeles					X
	Seattle Comm. Coll. - Seattle	X				
	Shoreline Comm. Coll. - Seattle	X				X
	Spokane Comm. Coll. - Spokane	X	X			
	Tacoma Voc. Tech. Insti. - Tacoma	X	X			
	Clark College - Vancouver	X	X			X
	Wenatchee Valley Coll. - Wenatchee	X	X			X
	Yakima Valley Coll. - Yakima	X	X			X
West Virginia	Potomac State Coll. - Keyser	X				X
	W. Va. Insti. of Tech. - Montgomery	X				
Wisconsin	Appleton Voc. Tech. Sch. - Appleton	X	X			
	Beloit College - Beloit					X
	Beloit Sch. of Voc. Tech. - Beloit	X	X			
	Eau Claire Sch. of Voc. Tech. - Eau Claire	X	X			
	Fond du Lac Tech. Insti. - Fond du Lac	X	X			
	Green Bay Sch. of Voc. Tech. - Green Bay	X	X			
	Univ. of Wisconsin - Green Bay					X
	Kenosha Tech. Insti. - Kenosha	X	X			
	Coleman Tech. Insti. - La Crosse	X	X			
	Sch. of Voc. Tech. - Madison	X	X			
	Stout State Univ. - Menomonie				X	
	Milwaukee Insti. of Tech. - Milwaukee	X	X			
	*Milwaukee Sch. of Engrg. - Milwaukee	X				
	Oshkosh Tech. Insti. - Oshkosh	X	X			
	Racine Tech. Insti. - Racine	X				
	Univ. of Wisconsin - Racine					X
	Sheboygan Voc. Tech. - Sheboygan	X	X			
	Univ. of Wisconsin - Sheboygan					X
	Sch. of Voc. Tech. - Superior	X	X			
	Two Rivers Sch. of Voc. - Two Rivers	X				
	Marathon County Tech. - Wausau	X	X			
	Wausau Tech. Insti. - Wausau	X				
	West Allis Sch. of Voc. Tech. - West Allis	X	X			
	Sch. of Voc. Tech. - Wisc Rapids	X	X			
Wyoming	Casper College - Casper	X		X		X
	Northwest Comm. Coll. - Powell					X
	Sheridan College - Sheridan	X				
	Goshen County Comm. Coll. - Torrington					X

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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS
AMERICAN SOCIETY FOR ENGINEERING EDUCATION
AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS
AMERICAN SOCIETY FOR TESTING AND MATERIALS
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AMERICAN INSTITUTE OF CONSULTING ENGINEERS
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SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS
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ENGINEERING SOCIETY OF CINCINNATI
LOUISIANA ENGINEERING SOCIETY
NORTH CAROLINA SOCIETY OF ENGINEERS
WASHINGTON SOCIETY OF ENGINEERS
ENGINEERING SOCIETIES OF NEW ENGLAND
SOUTH CAROLINA SOCIETY OF ENGINEERS
LOS ANGELES COUNCIL OF ENGINEERING SOCIETIES
HARTFORD ENGINEERS CLUB
INTERNATIONAL MATERIAL MANAGEMENT SOCIETY (NEW JERSEY CHAPTER)
CHINESE INSTITUTE OF ENGINEERS (NEW YORK)

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NATIONAL INSTITUTE OF CERAMIC ENGINEERS
SOCIETY FOR NONDESTRUCTIVE TESTING
INSTRUMENT SOCIETY OF AMERICA
AMERICAN SOCIETY FOR QUALITY CONTROL
INTERNATIONAL MATERIAL MANAGEMENT SOCIETY
SOCIETY OF WOMEN ENGINEERS
AMERICAN INSTITUTE OF PLANT ENGINEERS
SOCIETY FOR THE HISTORY OF TECHNOLOGY